Canada

Manitoba
CONSERVATION

Winnipeg

FLOOD PROTECTION STUDIES FOR WINNIPEG

PROGRESS REPORT

MAY 2001

KGS GROUP

KONTZAMANIS • GRAUMANN • SMITH • MACMILLAN INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

KGS FILE NO 00-311-07 36-PROGRESS REPORT Cover2 CDR

101-05849/

PROGRESS REPORT ON

FLOOD PROTECTION STUDIES FOR WINNIPEG

MAY 2001

REPORT CONTEXT

This study was scheduled to be carried out in a period of approximately 8 months and is an aggressive undertaking, given the complexity of the issues involved. This report presents the progress and preliminary findings up to the end of March, 2001. It also identifies areas where work will be required in the latter phase of the study.

It is important that this report be read in proper context. Thorough reporting of the findings and study issues would require a detailed, lengthy document, even at this early point in the study. It was agreed with the client group at the outset of the study program, that the Progress Report need not consist of full documentation of all work up to that point. The objective of this decision was to minimize the loss of productive investigative time, while still providing a reasonable "snapshot" of the study progress. That philosophy has been followed in the preparation of this document.

The results reported herein are preliminary and are offered as a basis for discussion with the client group and other stakeholders. Similarly, all cost and damage estimates that are provided herein are ***preliminary***, and will be refined in the cost engineering that is scheduled to be undertaken in the latter part of the Work Plan.

Other very important points regarding the context of the report :

1. Engineering of the Ste Agathe Detention Structure has not been advanced beyond the pre-feasibility level of study, nor will it be advanced further before the end of this study. It was deemed that the social issues that are being studied in this phase need to be addressed and examined carefully before a decision to undertake more advanced project definition planning can be justified.

2. The Floodway Expansion design has to this point been based on an assumed maximum water level at the Floodway Inlet at El 778 ft, which is above the "state of nature" condition at that location. Other options, such as maintaining the "state of nature" water level for the design condition will be much more expensive, but will be addressed in more detail before issue of the final report.

SUMMARY OF FINDINGS TO DATE

In early 2000, KGS Group submitted a study report on "Flood Protection for Winnipeg" to the International Joint Commission. That report identified two major flood protection schemes that, if constructed, could substantially reduce Winnipeg's exposure to the risk of major flood damages. It also listed over fifty recommended actions that should be undertaken to move towards the objective of improved flood protection.

In December of 2000, the Province of Manitoba commissioned KGS Group to carry out additional studies of the two major flood protection options – the Red RiverFloodway expansion and the Ste. Agathe Detention Structure. The work was subsequently approved under the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection. The City of Winnipeg also agreed to become a funding partner and to participate in the study.

The objectives of the present studies consist of carrying out the following broad tasks:

- Key engineering investigations that would assist in better definition of the steps required to expand the Red River Floodway ("Floodway").

- Refinement in the estimated cost of expansion of the Floodway.

- Limited engineering studies of the Ste. Agathe Detention Structure to improve its capabilities and reduce its negative impact on the Red River Valley upstream. The engineering was limited in scope because it was considered that social and environmental issues were more important in the decision of whether the concept should be considered further.

- Socio-economic studies to identify impacts, issues, and means to improve both concepts of flood protection.

- Environmental studies of the engineering works associated with both major concepts, so that impacts can be mitigated by implementing modifications to the designs as they evolve.

The purpose of this Progress Report is to provide an initial indication of the key findings to date. These findings are as follows:

Floodway Expansion

1. A stage-discharge relationship has been estimated for the Red River at the Outlet of the Floodway that is lower than previously adopted by KGS Group in previous studies for the IJC. Evidence from large floods, including 1997, 1826 and 1852 (the three largest floods in the last 200 years), has been examined and analysed to lead to the recommendation of this relationship. As a result of the generally lower water levels that are predicted for extreme floods, the potential for flooding in Winnipeg due to backwater effects from down-river is less than previously considered. The cost of the protection works in Winnipeg, including permanently raising of the crest level of the Primary Dikes is no longer required for the protection scheme for a 1 in 500 year flood.

2. The bridges over the Floodway have been reviewed in detail. A scheme has been developed to "retrofit" the bridges to provide enough cross sectional flow area to achieve the design flood flow capacity. This avoids the high cost of full replacement. The "retrofit" involves channel deepening, protection of the piles and pier bases, and strengthening of the connection of the bridge girders to the piers. This approach permits a substantial reduction in overall cost to the Floodway expansion for a flood of 1 in 500 years.

3. Planning of the Floodway channel expansion to best suit the bridges and the varying degree of difficulty of excavation along the Floodway has led to a concept of a varying channel cross section. This variation would be done very gradually along the channel length so as not to introduce inefficiencies in flow-carrying capability or other adverse effects. It is anticipated that a saving in channel excavation cost could be at least 10% over a strategy of using a standard channel cross section consistently along the channel. This concept requires further examination and verification in the second half of the study, before it is firmly recommended.

4. As a result of the lower water levels noted in #1 above, the practical limit of Floodway expansion has been raised from a 1 in 500 year to a 1 in 1000 year flood event. An alternate channel arrangement capable of passing the 1 in 1000 year flood is being studied to supplement the main focus of the engineering for the 1 in 500 year flood.

5. The Floodway channels that have been devised for both flood magnitudes (1 in 500 and 1 in 1000 year) have been based on reliance on the ultimate hydraulic capacity that could be provided by the channel when the Red River water level at the Floodway Inlet is allowed, under emergency conditions, to rise to El 778 ft. It should be noted that protection provided by these Floodway channel options with the water level held at the "state-of-nature" at the Floodway Inlet would be approximately 1 in 250 year and 1 in 700 year, respectively.

6. Cost reviews are underway, but it clearly appears that the cost of the 1 in 500 year Floodway will be lower than estimated during previous studies. A cost of about $600 to $650 million has been roughly estimated at this point. On-going cost studies will refine and itemize that estimate.

7. Cost estimation has not commenced for the Floodway Expansion for a 1 in 1000 year flood. However, the previous pre-feasibility estimate prepared by KGS Group for the IJC showed a cost of approximately $1.1 billion. That estimate will be refined in the second half of this study.

Ste. Agathe Detention Structure

1. Engineering studies of the Ste. Agathe Detention Structure have not been extensive. However, modifications to the original concept reported to the IJC have been devised to eliminate concerns that arose in more detailed examination of the preliminary concept. Specifically, the following improvements have been made:

   - The increase in water levels caused by the structure at floods less than 1 in 100 year magnitude has been eliminated

- The freeboard on the structures has been increased to at least 6 ft during passage of the Probable Maximum Flood

- The emergency fuseplug dike has been eliminated.

2. The capital cost of the Ste. Agathe Detention Structure is estimated to increase to approximately $390,000,000. The increase was governed almost entirely by the first improvement cited above. On the other hand, the estimated present value of future operation and maintenance costs has decreased substantially from the previous studies. In total, the cost that has been associated with the Ste. Agathe Detention Structure is now $495,000,000, compared to $475,000,000 reported by KGS Group to the IJC. This includes an estimated $21,000,000 in present value of average annual damages in the area south of the Ste. Agathe structure. This component is under review and will be refined before issue of the final report for this study.

3. The Ste. Agathe Detention Structure would not adversely affect the peak flood water level on the Red River at the Canada-U.S. border for floods up to and including the 1 in1000 year magnitude.

   However, there appears to be a backwater effect on the receding portion of the flood hydrograph that would cause a delay in the Red River water level receding to a bankfull condition at Emerson. This delay was shown to occur for all floods exceeding the 1 in 300 year magnitude. The delay is relatively minor, only approximately a 2 to 4 day delay in a flood hydrograph that is over 25 days in duration. Nonetheless, this may constitute a concern in the U.S. and will be addressed in more detail.

4. The Ste. Agathe Detention Structure is a complex development and would require considerable further study before advancing to a full feasibility level of confidence.

Socio-Economic Findings

1. Flood easements do not appear to be the best solution for compensating upstream residents for incremental damages. Consequently, the estimated costs for either project that are presented as preliminary have not included a component for easements.

2. Compensation for incremental, project-induced damages would have to be paid when an event occurs. This amount will be factored into the project cost/benefit analysis in this study.

3. Compensation guidelines are the responsibility of the Province of Manitoba. The appropriate amount of compensation should correspond closely to the damage estimates to be produced by the damage models currently used. These estimates, which are currently being developed, are based on existing compensation criteria.

4. Due to the sensitive nature of these project-induced damages, expansion of the compensation guidelines may be justified and may include damages not currently eligible for compensation. Expanded compensation should consider business interruption losses and the expansion or removal of limits on compensation allowances. This could add 20 to 30% to the compensation amounts for a flood event.

5. With regards to property value loss as a result of either flood protection alternative, initial assessment suggests that there may not be a basis for property loss compensation in conjunction with the Ste. Agathe structure. A mechanism may be needed to compensate residents who sell their property during the first three to five years after construction of the project and after each flood event in which the project causes damage.

6. With regards to recreational opportunities, the most significant recreational benefits appear to result from regulation of Red River summer flows within the City of Winnipeg. Opportunities for development of recreational opportunities associated with a "Wet" Floodway appear to be limited. Of the two alternatives, Floodway expansion provides the greatest variety and opportunity for recreational opportunity development.

7. Public participation is expected to occur following this phase of study. Currently, a comprehensive approach is being explored which involves an educational component as well as consultation or involvement in the project selection process, in determining compensation measures and in setting operating rules.

Environmental Study Findings

1. According to Manitoba Regulation 164/88, under the Manitoba Environment Act, these Flood Control Projects are categorized as Class 3 Developments and will require an Environmental Licence. An Environment Impact Statement (EIS) will be required to determine the type and significance of environmental effects of the project.

2. A Comprehensive Environmental Study Assessment under the Canadian Environmental Assessment Act (CEAA) will be required. This will be triggered by the requirements associated with Federal Funding, the Fisheries Act or possibly the Navigable Waters Protection Act.

3. In the early planning stages of the environmental assessment, the harmonization of the various environmental assessment processes needs to be considered and be resolved early in the project initiation phase to ensure the assessment project.

4. The most significant impacts associated with the Floodway Expansion will be related to potential changes to the existing groundwater regime. These can be relatively well defined prior to construction and can be mitigated. They are currently being assessed in greater detail as a part of this study.

5. A number of relatively minor aquatic issues associated with the Floodway Expansion have been identified as a part of the on-going assessment and are not anticipated to have significant effects.

6. The aquatic impacts associated with the "Wet" Floodway scheme will be more substantial than the "Dry" Floodway and will require more rigorous assessment if the "Wet" Floodway moves forward as an attractive alternative.

7. The aquatic effects of the Ste. Agathe Detention Structure on the Red River and a number of smaller watercourses will be impacted by the structure and it's operation. These include the Rat River, the Marsh River, and Tourand Creek.

8. The Ste. Agathe Detention Structure is a complex scheme, which considers diversion of flows from the Red River, Marsh River and Rat River at varying flows. The most significant aquatic issues associated with fish passage and loss of habitat have been considered in the development of the current scheme. Should the project proceed to advanced levels of design, it is apparent that considerable additional effort will be required to define the nature of the impacts, to evaluate mitigation alternatives and to work with Fisheries and Oceans Canada (DFO) through the definition of compensation, if any may be required.

TABLE OF CONTENTS

PAGE

REPORT CONTEXT i

SUMMARY OF FINDINGS TO DATE ii

ENVIRONMENTAL STUDY FINDINGS vii

1.0 INTRODUCTION 1

2.0 ENGINEERING STUDIES 4
2.1 RED RIVER FLOODWAY EXPANSION 4
2.1.1 General 4
2.1.2 Red River Hydraulic Studies 5
2.1.3 Raising Permanent Crest Levels of Primary Dikes in Winnipeg 9
2.1.4 Upgrading of Flood Protection Infrastructure in the City of Winnipeg 9
2.1.5 Floodway Bridges 11
2.1.6 Floodway Channel Modifications 13
2.1.7 Revised Estimated Costs of Floodway Expansion 16
2.1.8 "Wet" Floodway Concept 17
2.1.9 Control of Water Levels in Winnipeg 20

2.2 STE. AGATHE DETENTION STRUCTURE 22
2.2.1 Introduction 22
2.2.2 Description of Revised Project Arrangement 23
2.2.3 Design Criteria of Revised Ste. Agathe Detention Structure 24
2.2.4 Description Of Structures 26
2.2.5 Operating Conditions 30
2.2.6 Reservoir Flood Levels 31
2.2.7 Revised Estimated Costs of Ste. Agathe Detention Structure 33
2.2.8 Precedents of Selective Flooding Concept 35

3.0 BIOPHYSICAL ENVIRONMENTAL STUDIES 36
3.1 GENERAL 36
3.2 REGULATORY FRAMEWORK 36
3.3 FLOODWAY EXPANSION 38
3.3.1 Groundwater Impacts 38
3.3.2 Aquatic Considerations 38
3.3.3 "Wet" Floodway 40
3.4 STE. AGATHE DETENTION STRUCTURE 41
3.4.1 General 41
3.4.2 Potential Impacts and Mitigation 41

TABLE OF CONTENTS
(CONTINUED)

PAGE

4.0 SOCIO-ECONOMICS STUDIES 43
4.1 INTRODUCTION 43
4.2 SOCIO-ECONOMIC INDICATOR ANALYSIS 43
4.3 COMPENSATION ANALYSIS 49
4.4 RECREATIONAL OPPORTUNITIES 53
4.5 PUBLIC PARTICIPATION PLANNING 54

5.0 ORGANIZATION FOR IMPLEMENTATION OF MAJOR PROJECT 60

6.0 ON-GOING STUDIES 61

TABLES
FIGURES
PLATES
APPENDICES

LIST OF TABLES

Table 2.1 Revision To Pre-Feasibility Cost Estimates of Floodway Expansion (1 in 500 Year Design Flood) 16
Table 2.2 Revision To Pre-Feasibility Cost Estimates of Floodway Expansion (1 in 1000 Year Design Flood) 17
Table 2.3 Revision To Pre-Feasibility Cost Estimates of Floodway Expansion 34
Table 4.1 Study Area Socio – Economic Characteristics 44
Table 4.2 Ste. Agathe and Floodway Expansion Options Compared to the Existing Floodway 45
Table 4.3 Ste. Agathe and Floodway Expansion Options Compared to Each Other 45

LIST OF FIGURES

Figure 2.1 Stage-Discharge Relationship for Red River at Floodway Outlet As Used by KGS Group for IJC 6
Figure 2.2 Proposed Stage-Discharge Relationship for Red River at Floodway Outlet 7
Figure 2.3 Stage-Discharge Relationship for Red River at Floodway Entrance 15
Figure 2.4 Stage-Discharge Relationship At Ste. Agathe Site 26
Figure 2.5 Water Surface Levels with Ste. Agathe Detention Structure 31
Figure 2.6 Peak Water Level Hydrographs of Red River at Emerson – 1 in 1000 Year Flood (With and Without Ste. Agathe Detention Structures) 32
Figure 2.7 Water Level Hydrographs of Red River at Emerson – 1 in 300 Year Flood (With and Without Ste. Agathe Detention Structure) 33
Figure 4.1 Summary of Public Participation Choices 59
Figure 5.1 Proposed Structure for Implementation of Major Flood Protection Project for Winnipeg 60

LIST OF PLATES

1. Typical Highway Bridge Modification
2. Typical "Retrofits" to Bridge
3. Stratigraphic Profile Along Center of Floodway Channel
4. Arrangement of Principal Structures
5. Arrangement of Principal Structures
6. Red River Control Structure
7. Marsh River Control Structure
8. Rat River Control Structure

LIST OF APPENDICES

A. Work Plan
B. List of Proposed Measures For Improvement of Flood Protection Infrastructure In City of Winnipeg

1.0 INTRODUCTION

In early 2000, KGS Group submitted a study report on "Flood Protection for Winnipeg" to the International Joint Commission. That report identified two major flood protection schemes that, if constructed, could substantially reduce Winnipeg's exposure to the risk of major flood damages. It also listed over fifty recommended actions that should be undertaken to move towards the objective of improved flood protection.

In December of 2000, the Province of Manitoba commissioned KGS Group to carry out additional studies of the two major flood protection options – the Red River Floodway expansion and the Ste. Agathe Detention Structure. The work was subsequently approved under the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection. The City of Winnipeg also agreed to become a funding partner and to participate in the study. KGS Group is reporting to a Steering Committee that was appointed by the client group, and consists of the following individuals :

- L. Whitney (Chairman of Steering Committee) – Manitoba Conservation
- D. Bodaly - Government of Canada – Fisheries and Oceans
- R. Halliday Consultant
- B. Lukey - Consultant, previously Chief Engineer for PFRA
- D. McNeil - City of Winnipeg
- H. Schellenberg - Manitoba Agriculture and Food
- A. Vermette - PFRA

The advice and support provided by the Steering Committee are gratefully acknowledged.

The objectives of the present studies consist of carrying out the following broad tasks:

- Key engineering investigations that would assist in better definition of the steps required to expand the Red River Floodway ("Floodway").

- Refinement in the estimated cost of expansion of the Floodway.

- Limited engineering studies of the Ste. Agathe Detention Structure to improve its capabilities and reduce its negative impact on the Red River Valley upstream of the structure.

- Socio-economic studies to identify impacts, issues, and means to improve both concepts of flood protection.

- Environmental studies of the engineering works associated with both major concepts, so that impacts can be mitigated by implementing modifications to the designs as they evolve.

The rationale for undertaking only limited engineering, as listed in the objectives, was that the socio-economic and environmental impacts of the project are clearly more important at this stage. Refinements in cost estimation that could be provided on the basis of more detailed engineering would not likely affect the decision on whether the project is acceptable to Manitobans. The socio-economic and environmental evaluations will form the basis of the decision whether to further investigate the project, and have been the focus in this study. More detailed engineering would be carried out later, if the project is deemed to justify further consideration.

Details of the agreed Work Plan are provided in Appendix A.

Two elevation datums have been used in the study and in this report, that have been commonly adopted by previous planners/designers. They are:

- Canadian Geodetic Vertical Datum, 1928 (1929 adjustment), with Horizontal NAD ,1983, referenced to June, 1990

- James Avenue Pump Station Datum (JAPSD) (gauge zero El 727.57 ft Canadian Geodetic Vertical Datum).

Unless elevations are specifically stated as JAPSD, they refer to Canadian Geodetic Vertical Datum (CGVD). The Imperial System of measure has been used throughout this report since most of the basic data available for the study is expressed in that system.

There are references throughout this report to peak flood flows in the Red and Assiniboine Rivers. Unless otherwise identified as actual recorded flows, or as regulated flows that include the effects of diversions or reservoirs, these flood flows are of the magnitude that would have occurred if the existing flood control system did not exist.

The annual probabilities of flood magnitude being exceeded that were used in this study were provided by the Province of Manitoba. They are as follows:

Annual Probability of Flood Being Exceeded	State-of-Nature River Flows (cfs)	
	Red River at Floodway Inlet	Red River at James Avenue
1 in 50	105,000	135,000
1 in 90	135,000	163,000
1 in 200	170,000	200,000
1 in 300	193,000	225,000
1 in 500	210,000	250,000
1 in 1,000	250,000	295,000
Estimated Probable Maximum Flood	400,000	450,000

2.0 ENGINEERING STUDIES

2.1 Red River Floodway Expansion

2.1.1 General

The scheme of Floodway Expansion that was developed by KGS Group in the study conducted for the IJC consisted of the following major components:

- Expansion of the Floodway channel
- Modification of bridges, transmission lines, and other facilities that cross, or are located immediately adjacent to, the existing channel
- Modifications of the Floodway Outlet Structure
- Upgrading of the flood protection infrastructure within Winnipeg to permit a sustained flow of approximately 80,000 cfs through the city.
- Increase in Primary Dike height in parts of Winnipeg to protect against the backwater effects of high Red River levels below the confluence of the Floodway channel at its outlet.
- Increase in height of the West Dike to provide additional security against wind effects on the "Red Sea" during major flood events.

The current study has focussed on each component described above, with the intent of improving the knowledge of the work and construction that would be required to implement them. This planning includes improvement in the accuracy of the cost estimates. The following Sections 2.1.2 to 2.1.6 describe the results of the major findings to date.

Additional issues related to the Floodway have also been addressed as part of the study program. They are :

- The potential for adoption of an alternate means of expanding the Floodway using a design concept that results in retention of an impounded body of water during the summer months (the "Wet" Floodway concept)
- The use of the Floodway to control water levels in Winnipeg during summer flood events

These issues are discussed in Sections 2.1.8 and 2.1.9, respectively.

2.1.2 Red River Hydraulic Studies

KGS Group's studies for the IJC showed that, under very high river flows, there could be backwater effects that could cause flooding in Winnipeg, regardless of efforts to expand the Floodway. The estimated extent of this potential is contingent on interpretation of high water levels that have been estimated to have occurred in the 1826 flood event. Forensic engineering analysis of those records was not possible within the time frame and budget constraints of the IJC study.

As a result, a conservative and pragmatic approach was necessary in that previous study. It involved the use of an enveloping curve that directly reflected both the observed high water levels in the Red River in 1997, as well as those reported to have occurred in 1826. The stage-discharge relationship that was adopted for the IJC study is shown in Figure 2.1. The impact of using that relationship was that a backwater effect was shown to occur in Winnipeg for flood flows exceeding 200,000 cfs. Protection of Winnipeg in association with a Floodway Expansion designed for a 1 in 500 year flood would require special measures because of the backwater effect. Those measures in Winnipeg to combat the high water levels would include raising the Primary Dikes in the north end of Winnipeg by as much as 3 ft. The total cost of the measures in Winnipeg to combat the high water levels was estimated to be $110,000,000 and formed part of the cost of the Floodway Expansion scheme in the results reported to the IJC.

The current study has provided the time and funds to more thoroughly investigate the hydraulic characteristics of the lower Red River. The following studies have been completed:

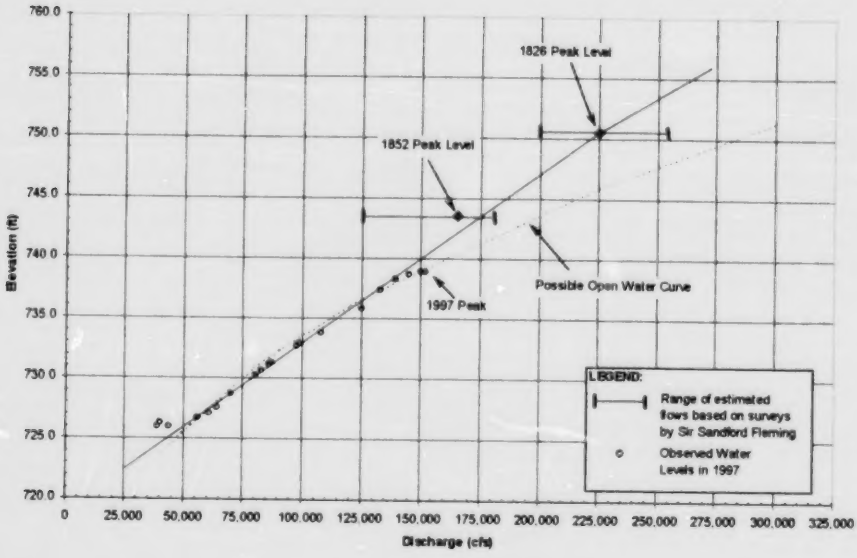
- Refinement and calibration of a numerical model of open water flow conditions from Lockport to Lake Winnipeg, based on data collected over the last 50 years.

- Review of reports describing the 1826 flood, and surveys of high water marks associated with that event.

- Development of a numerical model of ice-covered flow conditions in the Red River, including calibration based on available information from recent ice jam events.

- Extension of that ice model to study various scenarios of ice jam formation.

Figure 2.1 - Stage-Discharge Relationship for Red River at Floodway Outlet As Used by KGS Group for IJC.



- Analysis of potential flow in a bypass route that was reported to have occurred in both the large floods of 1826 and 1852. That route carried flow from the Red River, starting in the area of the present location of North Winnipeg, carrying water about five miles to the west of Selkirk and returning it to the Red River near Netley Creek.

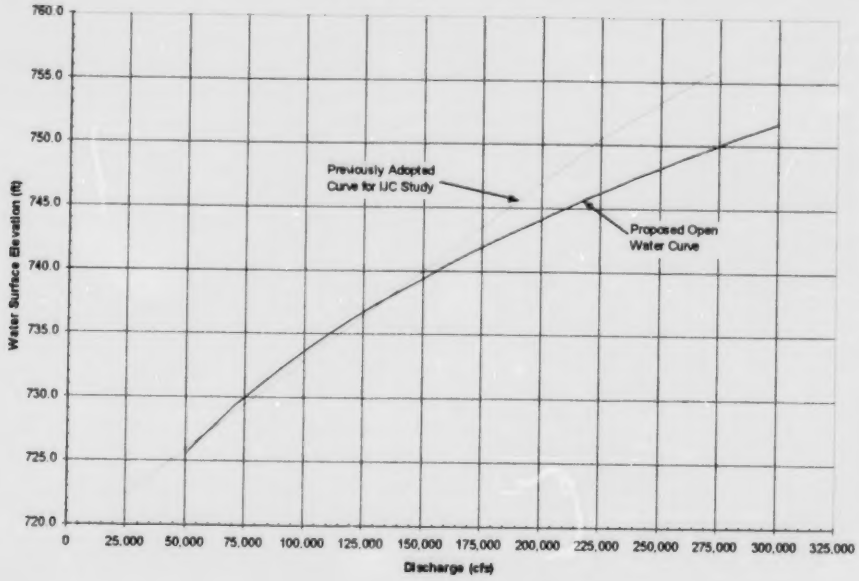
- Analysis of the probable onset of ice breakup.

- Surveys of overbank flow areas to confirm/refine estimates of ground levels that had initially been based on existing topographic maps.

The results of these studies have led KGS Group to conclude the following:

- The best estimate of the stage-discharge relationship of the Red River at the Floodway Outlet is as shown in Figure 2.2.

Figure 2.2 - Proposed Stage-Discharge Relationship for Red River at Floodway Outlet.



- Ice jams that could cause significant backwater effects at the Floodway Outlet at the peak of very high floods exceeding 150,000 cfs are highly unlikely in the area north of Lockport. Analysis using the state-of-the-art methods of evaluating ice jams suggest that such an ice jam cannot occur at such high flows in that area.

- The full set of estimated peak water levels from the 1826 flood event (surveyed high water marks at 11 locations from the Forks to Lake Winnipeg) are difficult to reconcile. There are several scenarios that could explain most of the levels and other anecdotal information at hand consistently. However, the fact that the peak water levels for the 4 mile reach below the Forks are equal is suspect. It is likely that they are approximations and that there was actually a slope in the water surface. Aside from this point, the possible scenarios are:

Scenario #1 - The peak water levels reported to have occurred in Winnipeg were estimated in error, and the levels in the Lockport to Selkirk reach were caused during open water conditions (no ice effects involved). An estimated flood peak flow exceeding 300,000 cfs for the 1826 event would be required to explain this scenario.

Scenario #2 - The water levels in Winnipeg occurred as reported, and the high water levels near Selkirk were caused during the early stages of the flood, and resulted from a temporary ice jam that was subsequently washed downstream and dissipated. An estimated flood peak flow of approximately 170,000 cfs for the 1826 event would be required to explain this scenario. A similar scenario would also explain the relatively high level in 1852 (See Figure 2.1).

Scenario #3 - There were morphological changes in the river between the time of the 1826 event and the surveys of the river in 1951 that are known to still be representative of the channel bathymetry. The peak flow in 1826 under this scenario is uncertain, because it would be a direct function of the extent of the channel changes, and those are unknown.

Scenario #4 - Some combination of the third scenario and either the first or second could also be conceivable.

- Any of the four explanations listed above would support the use of the stage-discharge relationship shown in Figure 2.2. The second scenario, however, is the most problematic. It would lead to a conclusion that high water levels, exceeding the crest elevations of the Primary Dikes in Winnipeg, could occur due to temporary ice jams in the Lockport/Selkirk area during the rising limb of the flood hydrograph. However, if this were to occur, there is a possible and practical solution, as follows. If ice jams occur in the lower river and cause a water level near Lockport comparable to that reported for the peak of the 1826 event (this has never happened in the 33 years since the implementation of the Floodway and for at least 20 years prior to that), then a cutback of Red River inflow to Winnipeg would prevent flooding in the city. That cutback would be achieved by raising the gates at the Floodway Inlet Control Structure to raise the water level upstream. That would increase the diversion of flow into the Floodway channel and allow a cutback of flow in Winnipeg. While not being a desirable normal mode of operation, it could be resorted as an emergency measure under abnormal and infrequent conditions. Another mitigative measure could be weakening of the ice by saw-cutting or drilling of holes. However, that option would require further assessment.

The impact of these findings on the Floodway Expansion scheme is that the need for raising the permanent crest elevation of the Primary Dikes for a design flood of 1 in 500 year magnitude that was identified during KGS Group's study for the IJC has been eliminated. Corresponding reduction in the cost of the Floodway expansion scheme identified in KGS Group's report to the IJC would be $110,000,000.

This finding also suggests that the practical limit for Floodway expansion could be increased, and that notion is addressed in the following section.

2.1.3 Raising Permanent Crest Levels of Primary Dikes in Winnipeg

As described in Section 2.1.2, the original scheme of expanding the Floodway included a cost component for the raising of Primary Dikes in north Winnipeg, and for the modifications of related facilities that would also be required. As explained in the previous section, this is not now required for the expansion of the Floodway for a 1 in 500 year design flood criterion. Furthermore, the reduction in the potential for backwater effects would suggest that the practical limit of Floodway expansion need not now be held at a 1 in 500 year flood, but could be increased. It is possible that raising the Primary Dikes on a permanent basis to the extent that had previously been envisaged could be carried out and could provide protection for a 1 in 1000 year flood condition. An alternate scheme of Floodway expansion for a 1 in 1000 year design flood has started to be addressed in this study. As part of this initiative, the cost associated with the raising of the Primary Dikes is being reviewed and refined. This refinement is being assisted significantly by the assembly of a database on the City of Winnipeg's facilities that is being done at this time in a separate development of a Flood Manual for routine use in flood-fighting in Winnipeg. The preliminary finding is that the cost of raising the Primary Dikes, and all related activities, will be at least the $110,000,000 that was estimated during the study for the IJC, and probably more.

2.1.4 Upgrading of Flood Protection Infrastructure in the City of Winnipeg

During the flood of 1997, it became clear that water levels approaching 25 ft (JAPSD) cause a sharp increase in the risk of failure of a variety of components of the flood protection system in Winnipeg. Preliminary plans for a number of enhanced diking / flood-proofing measures in the city were developed by the City of Winnipeg, and recommended for implementation. The

objective of this undertaking would be to provide reliable protection up to water levels of El 25.8 ft (JAPSD), and permit the safe passage of some 80,000 cfs through the city. These proposed measures were submitted originally to the Provincial / Federal Governments in May, 1997, for consideration in the Canada / Manitoba Flood-Proofing Program.

A detailed list of the proposed measures is given in Appendix B. For the purposes of analysis during KGS Group's study for the IJC, these measures were segregated into three broad categories, as follow:

Projects that are "Prudent to Do" – these are projects that KGS Group has assessed as candidates that should proceed, and are not associated with any particular flood protection improvement scheme. These projects are primarily associated with flood readiness and studies to facilitate information systems for the future. They are projects that are not readily assessed in a benefit-cost analysis. Their total cost is estimated to be $24,600,000 (1997 $). Some of this work has already been started by the City of Winnipeg (for example, preparation of a Flood Manual for floods up to the 1997 magnitude).

Projects that Provide Direct Protection against High River Water Levels – these include such items as increased dike heights, and isolation of secondary sewer systems on the water side of the Primary Dikes. These have been further segregated into two groups:

- Those that permit reliable protection up to a water level of El 23 ft (JAPSD), with an estimated cost of $26,300,000 (1997 $)

- Those that permit reliable protection up to a water level of El 25.8 ft (JAPSD), with an estimated cost of $47,600,000 (1997 $)

Projects that Provide Indirect Protection through Reduction in Flood Potential Caused by Inadequate Capacity in the Internal Drainage System in Winnipeg – These are primarily related to reduction in basement flooding and facilitating pumping in either the combined sewer districts or in the separate sewer districts. They are estimated to cost $121,000,000 (1997 $). The City of Winnipeg, however, has provided funding in its Five Year Capital Program for some of the projects in this category.

The first category (prudent to do) was recommended by KGS Group for implementation, and continues to be recommended.

The third category (indirect protection) can be assessed with a benefit-cost analysis to determine the economic extent of the work. However, it is a complicated and tedious procedure that is generally not undertaken until the flood protection plan is firmly established and detailed analysis of the land drainage system can be done. It is not being done at this time.

The second group (direct protection) was assessed by KGS Group in the study for the IJC, as "stand-alone" projects. They were shown to have benefit / cost ratios exceeding 1.0. These have now been re-examined as part of the proposed expansion scheme of the Floodway. The reason for this re-analysis was that there has to be a clear comparison of these measures with possible increments in size of the Floodway. If it is shown that the investment in a larger Floodway would be more cost effective than investing in the improvements in Winnipeg, then there would be no justification for these measures to form part of the Floodway expansion plan.

Preliminary results indicate that the increment in flood flow capacity provided by the upgrades cannot be more economically achieved by an increase in the amount of expansion of the Floodway. The current estimates suggest that obtaining that additional capacity to pass flood flow in the Floodway channel would cost about 20% more than the $73,900,000 investment described above for the second category of upgrades. Furthermore, some of these projects also have merit as short term measures to be undertaken while the major protective measure is being developed.

2.1.5 Floodway Bridges

The selection of the most cost effective means of expanding the Floodway is affected by the 13 (one of which is abandoned) bridges that cross the Floodway. Hydraulic studies have shown that a Floodway design flow associated with a 1 in 500 year flood event cannot be achieved without some enlargement at most of the bridges. The inefficiency that is caused by bridge piers, submerged bridge girders/decks is the main cause of this. While replacement of the bridges with new structures would be suitable to combat this, it is very expensive. Preliminary investigations during KGS Group's study for the IJC showed replacement costs to be in excess

of $150,000,000. The bridges are not more than 35 years old, and would normally be expected to serve an additional 40 years. There would be no significant financial incentive for full replacement at this time.

KGS Group has developed less expensive alternatives that permit a "retrofit" of the existing structures. The objective is to maximize the use of the existing bridge structures, and thereby minimize the cost of treatment of the bridges in contributing to the required increase in hydraulic capacity of the expanded Floodway. The scheme consists generally of:

- Increased resistance against hydraulically induced loads (including potential debris build-up) due to submergence of the girders and bridge deck. Bridge alterations to accommodate higher hydraulic loads include provisions to secure the bridge girders to the piers and to increase the stability of the piers.

- Expansion of the flow area at the bridges by deepening the channel up to as much as 15 ft, in conjunction with steepened side slopes from the existing 1 vertical on 9 horizontal to 1 vertical on 6 horizontal, possibly by stabilizing the clay slopes with rockfill shear keys as required.

- At the bridges where it is not feasible to significantly increase the depth of theFloodway channel, the increased flow area is provided by extending the existing bridges in length and widening the Floodway channel.

Typical proposed modifications to highway bridges are shown in Plates 1 and 2. These modifications are estimated to cost less than 25 % of the cost of full replacement, and are believed to be the most effective means to complement expansion of the Floodway.

Studies of the bridges are on-going, to optimize the Floodway channel at the bridges and also provide the lowest overall cost.

2.1.6 Floodway Channel Modifications

In KGS Group's study for the IJC, options of Floodway expansion were restricted to a constant enlargement in channel depth, channel width, or a combination of the two, along the 29 mile length of the channel. The cost estimation for that study was at a pre-feasibility level, and further optimization was not considered necessary, or appropriate, at that time.

As part of the current initiative of refined planning, it was considered that the potential for optimization of the channel geometry should be investigated. The extent of cost reduction that could be achieved by varying the channel design to suit local conditions at each point along its length, had to be quantified. The stratigraphy along the centre-line of the Floodway Channel includes clay units, glacial till and bedrock profiles, as shown on Plate 3. The following variations affect the overall cost of Floodway expansion to achieve a given design flow:

- Variable costs of excavation ranging from approximately $1.75 per cubic yard to $15 per cubic yard depending on material type, depth of excavation, and location within the channel.

- Variations in effectiveness of channel modifications from the perspective of hydraulic conveyance; for example, a deep, narrow channel is more efficient in passing flow than a shallow, wide channel.

- Least cost modifications that are possible at the bridges, and their impact on the overall discharge capacity of the expanded channel.

The best combination of channel modifications to minimize the overall cost of the expansion for a selected discharge capacity is not evident without detailed engineering assessment. An optimization technique has been developed by KGS Group to assist in identifying the best expansion plan. That technique is based on a computer program that uses information on soil types along the channel, and information on the other factors described above, to prescribe the most effective use of funds in the channel expansion. The program seeks the lowest cost for providing a selected increase in required discharge capacity.

Other factors that must be considered in this are:

- Incorporation of a low flow channel that permits complete draining of the Floodway in non-flood periods.

- Avoidance of rapid changes in cross sectional shape of the Floodway channel that could cause additional loss of energy and tend to offset any reduction in cost that may have been evident.

- Avoidance of Floodway channel shapes at any location that would promote sediment accumulation that could eventually diminish the discharge capacity of the channel.

- Avoidance of excessive Floodway channel deepening that could cause significant adverse impacts on groundwater conditions in the area.

Preliminary application of the optimization technique shows that cost reductions of at least $30,000,000 may be possible by intentionally planned variation of the Floodway channel geometry to suit the construction and hydraulic constraints. Results are currently being carefully analysed and interpreted to assist the preliminary design of the preferred scheme of Floodway channel modifications.

An important aspect of the Floodway Channel modifications is the design water levels and related flows. It must be clearly understood that, in the studies to date, the maximum hydraulic capacity of the Floodway has been considered to be at the maximum emergency condition with the water level at El. 778 ft. at the Floodway entrance. This is approximately 3 to 4 ft. above the "state-of-nature" water level, depending on the flood quantity being considered. This aspect is summarized graphically in Figure 2.3.

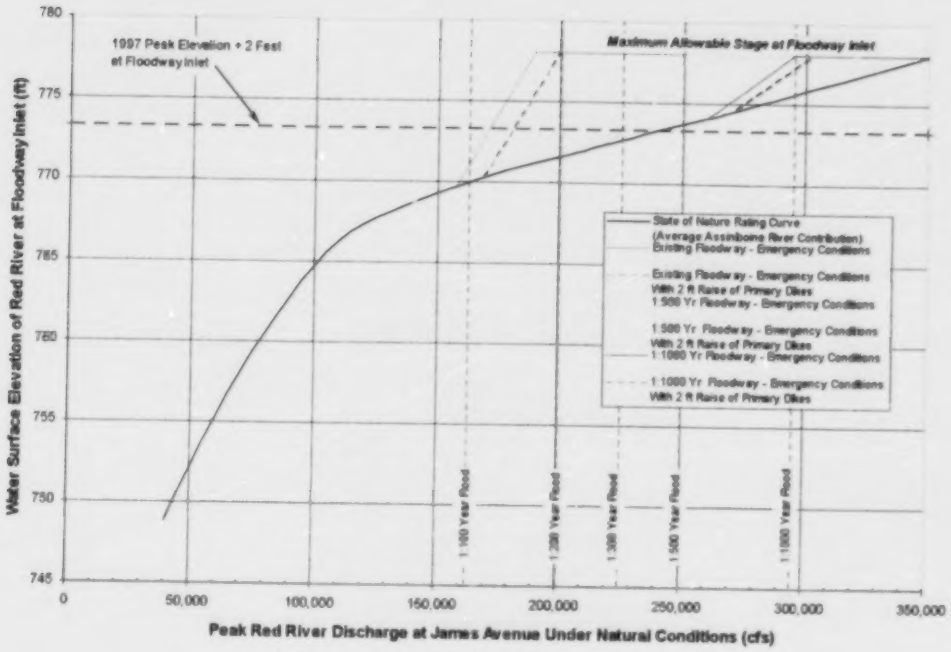

1997 Peak Elevation + 2 Feet at Floodway Inlet
Maximum Allowable Stage at Floodway Inlet
State of Nature Rating Curve (Average Assiniboine River Contribution)
Existing Floodway - Emergency Conditions
Existing Floodway - Emergency Conditions With 2 ft Raise of Primary Dikes
1:500 Yr Floodway - Emergency Conditions
1:500 Yr Floodway - Emergency Conditions With 2 ft Raise of Primary Dikes
1:1000 Yr Floodway - Emergency Conditions
1:1000 Yr Floodway - Emergency Conditions With 2 ft Raise of Primary Dikes
1:100 Year Flood
1:200 Year Flood
1:300 Year Flood
1:500 Year Flood
1:1000 Year Flood
Water Surface Elevation of Red River at Floodway Inlet (ft)
780
775
770
765
760
755
750
745
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
Peak Red River Discharge at James Avenue Under Natural Conditions (cfs)

Figure 2.3 - Stage-Discharge Relationship for Red River at Floodway Entrance

The basic curve shown in Figure 2.3 is the estimated stage-discharge relationship of the Red River at the Floodway entrance area for the "state-of-nature" condition with an average flood contribution assumed for the Assiniboine River. The sloping lines radiating above the "state-of-nature" curve indicate the water levels at the Floodway Inlet that would be required to maintain water levels in Winnipeg at El. 24.5 ft. (JAPSD). When the water level reaches 778 ft. at the Floodway Inlet, any further increases in inflow must be matched by increases in flow through the city.

The dashed lines represent the same conditions as described above, except with an allowance for an additional 10,000 cfs passing through Winnipeg. This would be possible without a major risk of flooding, with a 2 ft temporary raising of the Primary Dike level in Winnipeg.

The key point demonstrated in Figure 2.3 is that the water passage capability reaches the 1 in 500 year condition (or the 1 in 1000 year condition for the larger channel option) at a water level of approximately El. 778 ft. at the Floodway Inlet.

2.1.7 Revised Estimated Costs of Floodway Expansion

Detailed cost estimation is not completed at this point in the study. However, the findings of other parts of the work to date have indicated that a number of significant changes in the estimated cost of the Floodway expansion will result. At this juncture, it was considered of interest to review how those changes may affect the pre-feasibility cost estimate provided in KGS Group's report to the IJC. Tables 2.1 and 2.2 demonstrate how the costs of the 1 in 500 year Floodway and of the 1 in 1000 year Floodway may be affected. ***These are preliminary, and detailed cost estimation in the second half of the study may suggest other modifications.***

It should be noted that there is one item that has been intentionally excluded from Tables 2.1 and 2.2. That is the cost associated with flooding that would be caused upstream of the Floodway Inlet in extreme floods which require raising water levels above the state-of-nature to increase the flow through the Floodway. That item was excluded because the expanded Floodway reduces damages from the existing condition. Such reduction will be included in the benefits, and will be prepared in the second half of this study.

Table 2.1
Preliminary Revision To Pre-Feasibility Cost Estimates Of Floodway Expansion
(1 in 500 Year Design Flood)
(All Costs In Millions Of Dollars)

ITEM	PREVIOUS COST	PRELIMINARY REVISION	REVISED PRE FEASIBILITY COST ESTIMATE
Raise West Dike Crest 6 ft.	44	Inflationary Adjustment	45.6
Floodway Expansion	540	Reduce Excavation Costs Reduce Bridge Costs	490
Upgrade Flood Protection Infrastructure in City of Winnipeg[1]	74	Inflationary Adjustment	76.8
Raise Crest Level of Primary Dikes	110	Eliminate need for this component	0
Present value of Increment in Operation/Maintenance for Expanded Floodway[2]	0	Allowance for monitoring of slopes, bridge performance	0.1
TOTAL	**$768**		**$612**

Note: 1. These do not include costs to upgrade the internal drainage system in Winnipeg.
2. These are costs over and above those that would already be committed for existing Floodway.
3. The capacity to pass a 1 in 500 year flood is with a water level of 778 ft. at the Floodway Entrance.

Table 2.2
Preliminary Revision To Pre-Feasibility Cost Estimates Of Floodway Expansion
(1 in 1000 Year Design Flood)
(All Costs In Millions Of Dollars)

ITEM	PREVIOUS COST	PRELIMINARY REVISION	REVISED PRE-FEASIBILITY COST ESTIMATE
Raise West Dike Crest 6 ft.	44	Inflationary adjustment	45.6
Floodway Expansion	900	Reduce Excavation Costs	840
Upgrade Flood Protection Infrastructure in City of Winnipeg	74	Inflationary adjustment	76.8
Raise Crest Level of Primary Dikes	110	Increase cost estimate based on more detailed analysis	120
Present Value of Increment in Operation/Maintenance for Expanded Floodway[2]	0	Allowance for monitoring of slopes, bridge performance	0.1
TOTAL	**$1,128**		**$1,082**

Note: 1. These do not include costs to upgrade the internal drainage system in Winnipeg.
2. These are costs over and above those that would already be committed for existing Floodway.
3. The capacity to pass a 1 in 1000 year flood is with a water level of 778 ft. at the Floodway Entrance.

2.1.8 "Wet" Floodway Concept

In late 1999, Professor C. Booy developed a conceptual design of a Floodway expansion option that has been named the "Wet" Floodway. One of the key features of the "Wet" Floodway is the installation of a gated control structure at the downstream end of the Floodway channel. This gated structure could be used to impound water within the "Wet" Floodway, with the intention of turning the channel into a long, narrow "lake" during summer months. The main purpose of this "lake" is to suppress the growth of terrestrial vegetation in the expanded Floodway channel. Minimizing the growth of vegetation would decrease the hydraulic roughness of the channel, thereby increasing the channel capacity for passing spring floods. This would result in less excavation to achieve a desired flood discharge capacity than would otherwise be necessary. It is also believed that some recreational benefit from the "Wet" Floodway Concept would be realized by the use of the new man-made "lake" in summer months.

Operation of the "Wet" Floodway would be as follows. The "Wet" Floodway channel would be empty in preparation for an upcoming spring flood. In the event of a spring flood, the existing Inlet Control Structure on the Red River would be operated to force water into the "Wet" Floodway, using the same operational policy for the Floodway gates as has been done

historically. Once the peak of the spring flood has passed, and there is no longer any risk of flooding in Winnipeg, the gates on the downstream end of the floodway channel would be lowered to impound water in the "Wet" Floodway. Water would be retained until late fall, at which time the "Wet" Floodway would be drained in preparation for the next spring flood.

The water impounded in the "Wet" Floodway during summer months cannot be completely stagnant because of environmental reasons (see environmental impacts in Section 3.3.3). As a result, a minimum continuous base-flow is required in the "Wet" Floodway channel during the summer months when the downstream gates are partially closed. It is proposed that the required base-flow be diverted from the Red River into the "Wet" Floodway, at the location of the existing Floodway entrance. It is expected that the required base-flow is minimal, and could be as little as 500 cfs. This quantity of flow would "turn over" the entire volume of water impounded within the "Wet" Floodway once per week, which would help to mitigate the environmental issues discussed in Section 3.3.3.

Diversion of the base-flow into the "Wet" Floodway from the Red River will require modification to the existing weir at the Floodway channel entrance. The "Wet" Floodway is expected to require almost continuous base-flow between the months of June and October. The minimum water level at the Floodway entrance during these months of the year is typically El 734 ft to 736 ft, and is controlled to a large extent by the water level maintained at the St. Andrews Lock and Dam. El 734 ft has been adopted as a design headwater level for the low flow inlet to the "Wet" Floodway. Excavation for a single 20 ft wide sluiceway with an invert elevation of approximately 728 ft would allow transfer of the baseflow into the "Wet" Floodway channel from the Red River. An option that involves pumping of water from the Red River over the entrance weir and into the "Wet" Floodway channel is also being examined.

This concept has been examined in more detail than was possible during the study for the IJC. A preliminary design has been prepared. The cost of the concept was estimated relative to the conventional "Dry" Floodway expansion. Both were based on a design condition with a 1 in 500 year flood. The increment in cost for the "Wet" Floodway over the "Dry", or conventional, concept is estimated to be up to $20,000,000. ***That does not include the cost of the additional work that would be required to provide the entrance configuration that could permit control of water levels in Winnipeg (that issue is discussed more fully in Section***

2.1.9). There would also be on-going incremental operation and maintenance costs for the Outlet Control Structure that would not have been required otherwise. Means to reduce this cost increment are being examined.

The increase in cost of the "Wet" Floodway over the "Dry" Floodway concept is attributed mostly to:

- The fact that the impounded water only reduces the roughness of the channel bottom over the downstream half of the channel; it actually could increase the frictional resistance in the shallow zone near the upstream end of the summer pool where heavy wetland vegetation (weeds, willows etc.) would exist (this requires more research and the retarding effect on flow has not been included in the preliminary design at this time).

- The fact that full optimization of the channel excavation for the "Wet" Floodway expansion to minimize cost of construction is not practical. That approach would result in a shallow zone in the central area of the impounded pool that would defeat the recreational purpose of the "Wet" Floodway, and would be subject to heavy vegetative growth. The latter would adversely affect the required cost of the channel enlargement and make the cost higher than reported above.

- The relatively high cost of providing control gates and piers in the Outlet Control Structure.

Refinement of the total cost increment associated with the "Wet" Floodway will continue into the next part of this study. Other options, including the pump scheme that would permit a larger, deeper summer lake in the Floodway, will also be addressed.

While there may be recreational benefits associated with the "Wet" Floodway, there are also concerns:

- Inadequate availability of water from the Red River in dry periods to provide an adequate "turn-over" of the impounded water to prevent algal blooms. This situation is estimated to occur about 10% of the time, on average, in the summer period between June and October.

- The loss of vegetation will increase the vulnerability of the channel to erosion. Reduction in design flow velocity in the channel could reduce this potential but would require a significant increase in the cost increment over the "dry" channel described above. For example, use of a maximum design velocity of 5 fps to minimize the risk of serious erosion would require at least an additional $100,000,000 in construction cost. Alternatively, some reduction in erosion potential at more frequent floods than the 1 in 500 year design flood could be possible by using the control gates to restrict the hydraulic gradient in the channel. However, this possibility is limited by the potential for flooding the bridges at the lower end of the channel at relatively low flood flows. These bridges could be modified/raised, but at a substantial additional cost.

- Other undesirable features of the "Wet" Floodway are directly related to environmental factors, and are described in Section 3.

2.1.9 Control of Water Levels in Winnipeg

Water levels in Winnipeg have exceeded their normal summer range frequently in the past. It is estimated from flow records that they have approached or exceeded the elevation of the Assiniboine Riverwalk approximately 10% of the time since 1968 (inception of Floodway), in the annual period from June 1 to October 31. The recent abnormally wet years have made it appear to Winnipeggers that this has occurred more frequently. It is a common suspicion that the Floodway was designed inappropriately, and should have been made to be capable of controlling the summer flood levels in Winnipeg. The reality is that the summer floods were not a concern in the planning of the Floodway. The channel was designed to provide the least cost means of conveying large flood flows harmlessly around the city. The Floodway would have had to be over 15 ft deeper in some parts than it currently is, in order to provide summer control of water levels. Furthermore, a control structure such as that used at the entrance to the Portage Diversion would have been required, at an additional cost of many millions of dollars. The additional cost of the channel, and the cost of the entrance control structure would have added a major financial burden to a project that was already reputed by some to be a waste of taxpayers' money. The course of action at the time was understandable and justifiable.

Notwithstanding the history of the Floodway development, there are means of controlling water levels in Winnipeg, with or without an expanded Floodway. These schemes involve either of the following concepts, or a combination :

- Raising of the Floodway Inlet Control Structure gates for periods totalling, on average, about 10 % of the time between June 1 and October 31. This would result in:

    - Water levels in the Red River upstream of the Floodway Inlet Control Structure rising as much as 13 ft above the level that would have occurred under current conditions with the control gates in the lowered position (ie. not holding back water).

    - The rise in upstream water level would mobilize the Floodway flow capacity and reduce the flow into Winnipeg. This would be controlled to the point that flooding of the Assiniboine Riverwalk would be prevented.

    - The amount that the water level would have to be raised to achieve this would vary with the magnitude of the summer flood, and would be a minimum of about 9 ft, and a maximum of about 13 ft, for the existing Floodway. A similar range of 9 ft to about 11 ft would be required in the case of an expanded Floodway. Some flooding outside the natural river channel would be expected. The extent of this is being examined and will be provided in the final report.

- Or, construction of a concrete control structure in the entrance weir of the Floodway channel, much like the control structure that was built at the entrance to the Portage Diversion. This would have to be accompanied by an extensive excavation in the upper end of the Floodway (existing Floodway channel bottom is 5 ft higher than the water level that would be required to control the flooding at the Assiniboine Riverwalk). Such a scheme is estimated to cost at least $100 million for the existing Floodway, and more than $50 million for an expanded Floodway. Refinements of these cost estimates are underway. Some combination of raising the Floodway Inlet Structure gates during summer high flow periods, and building a low level inlet to the Floodway would reduce the overall costs considerably. Costs in the order of $20

million are believed to be possible, but there would be environmental impacts due to raising the Floodway Inlet gates during summer periods. This will be assessed further.

Further details of these schemes are being analysed and will be presented in the final report.

2.2 Ste. Agathe Detention Structure

2.2.1 Introduction

The study of flood protection improvements for Winnipeg that was carried out for the IJC was restricted to pre-feasibility assessments of optional measures. A preliminary project design for the option called the Ste. Agathe Detention Structure was prepared, and is described in some detail in KGS Group's report to the IJC. It was recognized at that time that there were some features of the scheme that should be improved. Although the main focus of the current study has not been on additional engineering of the Ste. Agathe Detention Structure, a limited amount of work has been done. That work has concentrated on three key improvements in the concept that were considered necessary to make it comparable to other options, from an engineering perspective. Those improvements are:

- Elimination of the small backwater effect that would be caused by the original layout of the structures for floods less than about the 1 in 90 year magnitude. With that arrangement, water levels upstream of the structure would exceed what would occur under current conditions without the structure, even for floods less than the 1 in 90 year magnitude that would trigger the use of the gates to protect Winnipeg.

- Replacement of the fuseplug dike with a more secure system involving an increased discharge capacity through the concrete control structure. The fuseplug dike was an economical means of providing discharge capacity for extreme floods approaching the Probable Maximum Flood (PMF). However, it could be argued to be undesirable for a water retention structure upstream of a major city.

- Provision of adequate flood discharge capacity in the concrete control structure(s) so that a freeboard of at least 6 ft could be available during passage of the PMF. This would comply with the current design guidelines recommended by the Canadian Dam Association.

The improvements in the pre-feasibility design of the project have been made and are described in the next section. It should be noted that the design is still considered preliminary. Full feasibility of the project could only be confirmed with more detailed engineering based on sub-surface investigation at the proposed site. Such a level of investigative detail was not considered appropriate until social issues are resolved and the concept is deemed to be acceptable to Manitobans.

The Ste. Agathe Detention Structure is designed to provide flood protection in the area north of Ste. Agathe to Lake Winnipeg for floods up to the 1 in 1000 year magnitude.

2.2.2 Description of Revised Project Arrangement

The principal structures comprising the Ste. Agathe Detention Structure are shown on Plate 4. The project would consist of the following:

- An earth dike across the valley extending from approximately Brunkild on the west to Tourand on the east (PTH 59). The axis of the dam at the Red River would be approximately 1 mile south of Town of Ste. Agathe. The total length of the dam would be about 25 miles.

- Discharges downstream would be controlled by two control structures. The primary structure would be located adjacent to the Red River and would discharge approximately 70 percent of the Red River flood discharge.

- An auxiliary control structure would be located just west of the Marsh River to handle the remainder of the flood discharge.

- A downstream flood discharge channel, approximately 5 miles long, would be constructed with the exit located just upstream from the Rat River confluence with the Red River and the channel entrance located on the Red River approximately 0.5 miles upstream from the primary control structure on the Red.

- A smaller diversion channel connecting the downstream flood diversion channel to the Rat River would also be constructed from the downstream flood diversion channel just downstream from the Marsh River Control Structure.

- A gated control dam would also be constructed at the Rat River. The purpose of the Rat River Control Structure would be to allow the Rat River to discharge past the dam without impedance during non-flood conditions on the Red River.

2.2.3 Design Criteria of Revised Ste. Agathe Detention Structure

The primary design criteria for the revised Ste. Agathe project are listed below:

- Flood discharges up to the 1997 flood of 135,000 cfs at the floodway inlet to be discharged without attenuation at the Ste. Agathe Detention Structure (approximately 1 in 90 annual probability of being exceeded).

- No increase in water levels upstream for all floods up to the 1 in 90 year flood.

- Allowance for boat and fish passage on the Red River to be provided through low level sluiceways with the invert level at approximate river bottom level.

- Capability of passing the Probable Maximum Flood (PMF) with a minimum of 6 feet freeboard above the static reservoir level (no wind).

- The control structures bays would be equipped with gates. The gates would be closed as required to limit the total discharge downstream from the dam to a maximum of 135,000 cfs for Red River flood discharges between 135,000 cfs and 300,000 cfs. (1 in 1000 year event).

- The reservoir storage volume would be sufficient to store the flood volume for the 1:1000 year flood event, without causing the outflow from the structure(s) to exceed 135,000cfs (approximately the state-of-nature flow for a 1 in 90 year flood).

- The flood discharge channel would have the capacity to pass approximately 30 percent of the Red River flow during the 1 in 1000 year flood event.

- The maximum flow velocity in the flood discharge channels (upstream and downstream) would be limited to 3 feet per second. This criteria is based on limiting head losses in the channel.

- The upstream flood discharge channel from the Red River to the Marsh River Control Structure would be constructed with an adverse slope to permit draining of the channel south to the Red River, when the Red River water level recedes below the Marsh River spillway crest level.

- There would be no control structures on the flood discharge channels (at either upstream or downstream ends). The depth of water in the channels would be governed by the Red River water level at the entrance and at the exit. Flow would only occur when the Red River water level exceeds the crest level of the Marsh River spillway crest level. This corresponds to a Red River flow of approximately 20,000 cfs.

- Fish passage on the Rat River would be provided by a gated control structure on the Rat River. The structure would have capacity to discharge the 1 in 100 year flood on the Rat River with velocities less than 5 feet per second. The base slab elevation of the control dam (invert level) to be set at the channel invert level.

- Side slopes of excavated flood discharge channel 6H:1V

- Dam fill side slopes 6H:1V

2.2.4 Description Of Structures

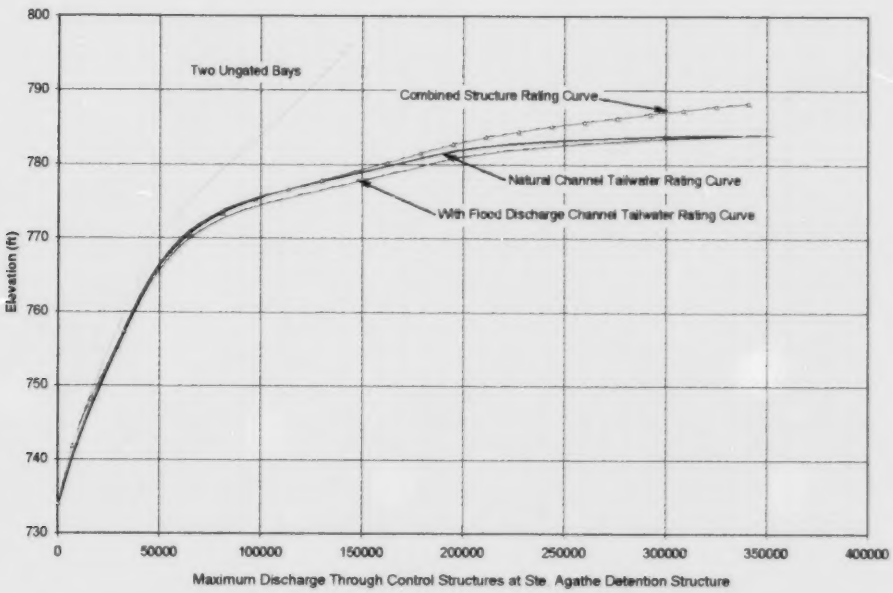
Red River Control Structure

The Axis of the Ste. Agathe Detention Structure at the Red River is proposed to be located at a meander bend in the Red River, approximately 1.5 miles upstream from the town of Ste. Agathe. The general arrangement of the control structure is shown on Plate 5.

The control structure would consist of 6 water passage bays. The two centre bays would be low level open sluiceways, each 60 ft wide, with their invert level at elevation 730 ft, which approximates the existing channel invert elevation. The backwater effect at low discharges would therefore be eliminated. The low level bays would serve to provide for boat passage and for fish passage during periods of low flow on the Red River. These bays would be ungated.

At maximum reservoir level, the discharge capacity of the two open bays would be approximately 125,000 cfs. The stage discharge relationship for these bays is illustrated on Figure 2.4.

Figure 2.4 – Stage-Discharge Relationship at Ste, Agathe Site.



It should be noted that two-dimensional hydraulic analyses of flow conditions upstream of the structure have not been included in the limited engineering scope for this study. It is possible that in more detailed design phases, it may be shown that further minor adjustment of the discharge capacity of the structures may be required. This adjustment would eliminate any minor backwater effects at the periphery of the flooded areas upstream. This adjustment to the current design would clearly be minor and would not affect the conclusions of this study.

The four outside bays would be 66 ft wide each, and would be equipped with gates to regulate the flow of water past the control structure when the discharge on the Red River exceeds approximately 135,000 cfs. The four bays would have standard ogee spillways with the crest level at elevation 745.0 ft. At maximum reservoir level, the combined capacity of the 6 bay Red River Control Structure, with all gates fully opened, is approximately 77 percent of the total Red River discharge.

The construction of the detention structure in the river and control structure would be a two-stage process. The location of the dam at the meander bend would be used to advantage to facilitate the construction of the dam and spillway. During Phase 1, the control structure, the approach channel and discharge channel would be constructed in the meander bend in the dry with upstream and downstream earth plugs remaining in place until the control structure channels have been completed. Water would continue to flow in the natural channel. During Phase 2, the earth plugs in the upstream and downstream channels would be removed and an earth cofferdam or dike would be constructed across the river to divert the flow through the completed control structure.

There is a concern with respect to the future upkeep of the Ste. Agathe Detention Structure. It is, by its nature, a structure that will not require operation frequently. It is likely that the gates would only have to be lowered once or twice to control floods in a 100 year period. Because of this infrequent usage, there is a concern that due diligence in maintenance of the gates and the hoisting system will not persist over many decades. It is conceivable that the gates and the related equipment, possibly even the concrete or earth structures, could suffer some reduction in reliability. On the other hand, there is no doubt that given appropriate annual funding, this risky situation could be avoided, by an operation and maintenance program which includes regular gate activation and repair.

Marsh River Control Structure and Flood Discharge Channel

The Marsh River Control Structure and flood discharge channel is an integral part of the Ste. Agathe project. The general arrangement of the structure is shown on Plate 7. The major components include:

- a two-bay gated control structure,
- a five-mile long downstream flood discharge channel, with the downstream channel exit located near the confluence of the Rat River and Red River and with the entrance to the upstream channel located approximately 0.6 miles upstream from the Red River Control Structure, and

- interconnecting channels to the Marsh River upstream and to the Marsh and Rat Rivers on the downstream.

The purpose of these project components is to provide additional discharge capacity for floods up to the 100-year return event and to provide additional capacity at maximum reservoir level to eliminate the need for the fuse plug dike concept used in the IJC study. Flood routing studies by Manitoba Conservation using the Mike-11 hydrodynamic numerical model showed that under existing natural river conditions, approximately 25 percent of the total Red River discharge flowed on the east flood plain of the Red River Valley (Rat/Marsh). Without these facilities, the flow would be concentrated in the Red River channel thus resulting in higher tailwater levels at the dam that would also produce increased upstream water levels. The structure is located near the Marsh River, with an interconnecting channel to the Rat River, and facilitates the spreading of the flow onto the flood plain, thus reducing the water level at the main structure in the river.

The arrangement of the control structure and channels is shown on Plate 4 and on Plate 7. The Marsh River Control Structure would be a two-bay gated control structure, each 66-feet wide with a standard ogee crest having a crest level at elevation 750 feet. The control structure would be equipped with radial gates, similar to those in the Red River Control Structure. The gates would normally be in the open position except during floods greater than 135,000 cfs (approximately 90 year return). At maximum reservoir level, the Marsh River Control Structure would discharge approximately 23 percent of the total Red River discharge.

The flood discharge channel is shown on Plate 4. The dimensions of the channel include:

- base width 160 feet
- side slopes 6H:1V
- the invert of the downstream flood discharge channel varies in elevation from 730 ft at the exit and elevation 735 ft at the Marsh River Control Structure.
- The invert elevation of the upstream flood discharge channel varies from elevation 735 ft at the channel entrance at the Red River, to elevation 736 ft at the Marsh River Control Structure. This adverse slope allows for the draining of water back from the upstream flood discharge channel to the Red River when river stages subside below the Marsh River Control Structure crest level after a flood event.

The flood discharge channels are an integral part of the Marsh River Control Structure. Their purpose is to provide flow through the Marsh River Control Structure when the water level in the Red River is below the flood plain level. The general flood plain elevation in the vicinity of Ste.Agathe is approximately 776 ft, which corresponds to a Red River water level that would occur at a river flow of more than 100,000 cfs. It also provides additional capacity to the Red River channel and to the east flood plain, in excess of the existing natural channel capacity. This additional flow capacity in the Red River will result in a lowering of the tailwater level at the Ste. Agathe Detention Structure compared to the "state-of-nature" water level at that location. The lower water level thus enables the passage of flood discharge with upstream water levels no higher than the "state-of-nature" levels.

The tailwater rating curves at the Ste. Agathe control structures for the flood discharge channel and for the existing conditions are illustrated on Figure 2.4. For example, the tailwater is lowered by approximately 1.2 feet with the flood discharge channel from the "state-of-nature" water levels when the river flow is 135,000 cfs.

The rating curve for the operation of the combined Red River and Marsh River control structures is also shown in Figure 2.4. The combined effect of the Marsh River Control Structure and flood

discharge channel results in upstream water levels at no higher than the existing water level for floods up to 135,000 cfs. Also, the total capacity of the combined structure exceeds the PMF discharge of 400,000 cfs in the Red River at elevation 791 feet.

Rat River Control Structure

The general arrangement of the Rat River Control Structure is illustrated on Plate 8. The structure would consist of the following:

- a gated two-bay control structure with each bay being 20 feet wide,
- an invert level at approximate stream invert elevation at the Rat River
- vertical slide gate and hoist each 20 feet wide and 20 feet high,
- a horizontal breast wall spanning each bay from elevation 768 feet to the top of the dam at elevation 798 feet,

During periods when the Red River is below flood stage, the gates in the structure would remain open and water would flow in the Rat River, as under existing conditions. The gates would be closed during flood conditions when Red River levels exceed the flood plain elevation. Rat River discharge would then be diverted overland to the Marsh and Red River Control Structures.

Management of Tourand Creek

Flow in Tourand Creek is relatively small, and is frequently zero. It is proposed that a drainage ditch be constructed adjacent to the upstream toe of the Ste. Agathe Detention Structure to convey the runoff from Tourand Creek into the Rat River at the Rat River Control Structure.

2.2.5 Operating Conditions

The Red River Control Structure would be operated to achieve the following conditions:

- The gates would remain fully opened in the raised position for Red River discharges less than 135,000 cfs (approximately the 1 in 90 year flood peak). This would result in state of nature levels upstream from the Ste Agathe dam,

- The gates would be lowered as required for Red River discharges greater than 135,000 cfs with a maximum release through the structure limited to 135,000 cfs. Excess water would be stored in the forebay.

- The maximum reservoir level attained at the dam during a flood event would depend on the volume of the flood event in excess of the 135,000 cfs discharge release.

2.2.6 Reservoir Flood Levels

Maximum water levels reached at various locations on the reservoir created by the detention structure are illustrated on Figure 2.5. The lines shown on the Figure 2.5 are envelope curves defining maximum water levels at any location and are not water surface profiles. For the 1 in 1000 year flood event for example, the maximum water level at Emerson would occur approximately 16 days earlier than at the Ste. Agathe Dam. These maximum water levels were computed by Manitoba Conservation using a flood routing numerical model of the Red River Valley, called "MIKE-11".

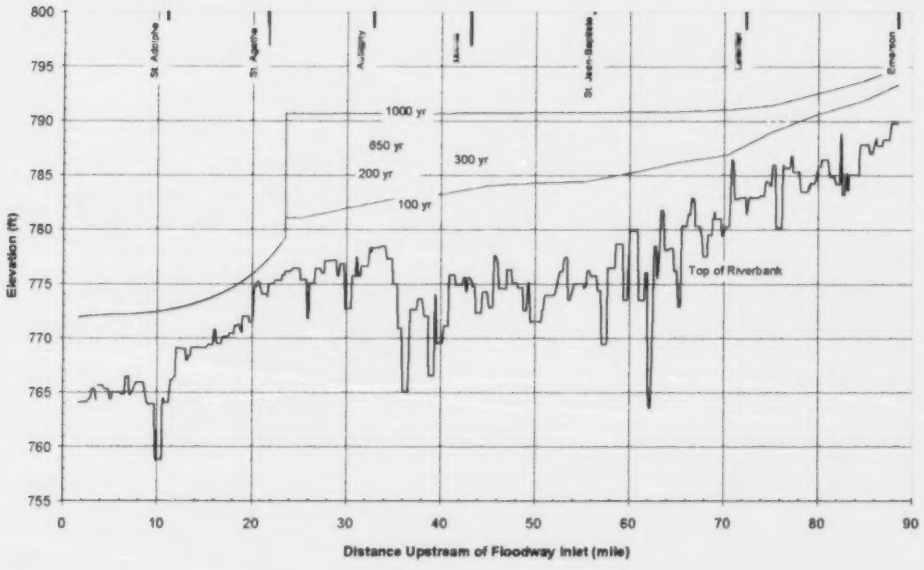


Figure 2.5 –Water Surface Levels with Ste. Agathe Detention Structure.

A comparison of the 1 in 1000 year water level hydrographs at Emerson (U.S./Canada border) are shown on Figure 2.5 for both "state-of-nature" conditions and with the Ste Agathe Detention Structure. The backwater effect, defined as the difference in the water level that would occur on any particular day during the flood event, is also evident in these Figures. As shown on Figure 2.5, the backwater effect at Emerson would be nil at the time of the peak stage of El 794.8 feet shown on April 25, but would increase after the water level has receded from the peak stage. For example, when the water level has receded about 3 ft below the peak stage during the flood, the backwater effect from the Ste. Agathe Detention Structure would be approximately 0.7 ft. This impact may constitute a concern for impacts of a Canadian project on U.S. interests. Further consideration of this is warranted.

Similar conditions are shown on Figure 2.7 for a 1 in 300 year flood event, with and without the Ste. Agathe Detention Structure. All results shown in Figures 2.6 and 2.7 were generated by Manitoba Conservation's numerical model of the Red River Valley ("MIKE-11").

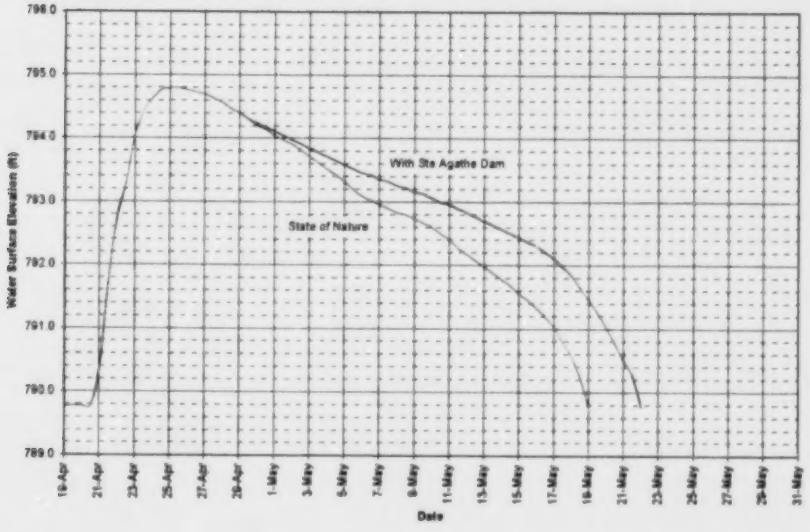


Figure 2.6 – Peak Water Level Hydrographs of Red River at Emerson – 1 in 1000 Year Flood (With and Without Ste. Agathe Detention Structures)

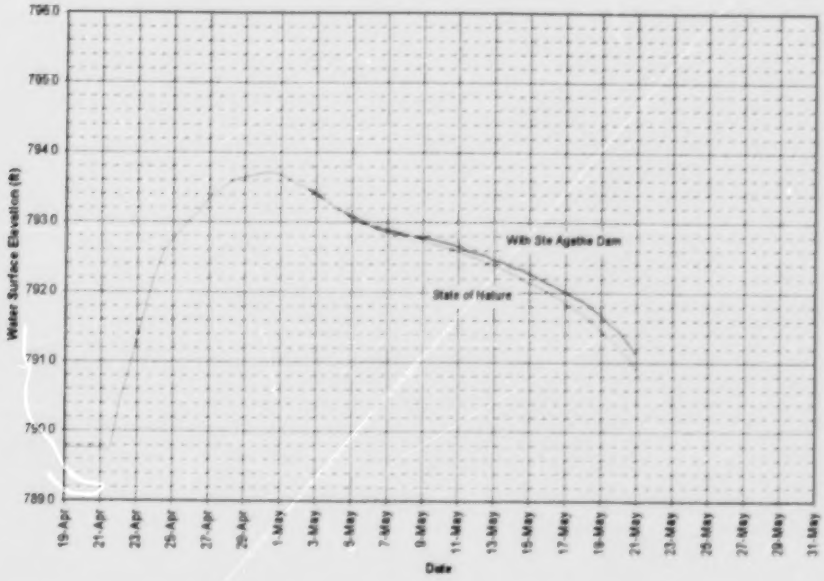


Figure 2.7 – Water Level Hydrographs of Red River at Emerson – 1 in 300 Year Flood (With and Without Ste. Agathe Detention Structure)

Similar graphs have been prepared for other locations in the Red River Valley, and for other flood conditions (lesser and greater peak flood flow). They are being analysed and will be issued for information separately.

2.2.7 Revised Estimated Costs of Ste. Agathe Detention Structure

The pre-feasibility capital cost estimate for the Ste. Agathe Detention Structure is estimated to be approximately $390,000,000. This is based on adjustments to the previous cost estimates which are summarized in Table 2.3. The overall cost of the project for comparative purposes to the Floodway Expansion is estimated at this time to be $495,000,000.

To be consistent with the procedure used in KGS Group's study for the IJC, a cost component has been retained which reflects potential damages that the Ste. Agathe Detention Structure would cause upstream during extreme floods. This component is based on the present value [based on an interest rate of 8% and inflationary trend of 4% (including 1% allowance for growth)] of estimated average annual incremental flood damages upstream of the Ste. Agathe Detention Structure.

Table 2.3
Revision To Pre-Feasibility Cost Estimates of Ste. Agathe Detention Structure
(1 in 1000 Year Design Flood)
(All Costs In Millions Of Dollars)

ITEM	PREVIOUS COST ESTIMATE	REVISION	REVISED PRE-FEASIBILITY COST ESTIMATE
Red River Control Structure	$57.25	2 more bays 1 less gate	$53.4
Detention Dike	$128	Rat River Structure costed separately	$126.5
Rat/Marsh Diversion	$23.75	New Rat River Control Structure	$8.0
Marsh River Control Dam	Not Required	New Structure	$26.7
Flood Discharge Channel	Not Required	New Channel	$36.8
Rat R Control Structure	Not Required	New Structure	$5.3
Utilities Impact	$1.0	Additional Impacts	$1.5
Indirect Costs	$105	Adjustment proportional to direct costs	$129
Present Value of Incremental Damages Upstream of Ste. Agathe Detention Structure	$21	No change at this time	$21
Present Value of Operation and Maintenance Cost of Ste. Agathe Detention Structure	$65	Refinement and definition of required O&M costs	$10
Upgrade of Flood Protection Infrastructure in Winnipeg	$74	Inflationary adjustment	$77
TOTALS	**$475**		**$495**

Table 2.3 includes an item for present value of operation and maintenance. This is a valid component that must be included in a fair comparison with the Floodway expansion. The previous estimate of this component by KGS Group for the IJC was a generous one, and was based on 1% of the capital cost of the project per year over the life of the project. This is in line with experience with hydroelectric structures. Information on flood control projects was not readily available at the time. A review in the current study was based on an actual cost of operation and maintenance for the existing Floodway structures/embankment/channels, and on an examination of annual activities that would be required to maintain the project in a safe and operable state throughout its life. An estimate of $500,000 per year was prepared, and results in a present value of 50 years of approximately $10,000,000.

Other items such as taxes and insurance are relatively minor and have not been included. They will be considered in refinements of costs to be documented in the final report.

2.2.8 Precedents of Selective Flooding Concept

The concept of incurring a relatively small amount of damage in one area to prevent major damages in another area, or to avoid more costly construction works, is controversial. A literature review, and polling of certain key agencies that are responsible for flood control, has been initiated. The following results are available:

- There are numerous precedents of permanent reservoir creation that required expropriation of local residents in the flooded zone. However, that is not directly comparable to the situation at Ste. Agathe.

- There are a few precedents where limited flooding of primarily agricultural land has been caused in order to protect downstream interests. Precedents are the Oder River, Germany, the Po River, Italy, and the Rhine River, Germany. Detailed information has not yet been obtained, but initial descriptions suggest that these sites are also not directly comparable to Ste. Agathe.

Further inquiries will be carried out and reported at the end of this study.

3.0 BIOPHYSICAL ENVIRONMENTAL STUDIES

3.1 General

An overview of the engineering aspects of the Red River Floodway Expansion and Ste. Agathe Detention Structure is given in Sections 2.1 and 2.2, respectively. Although the projects are still at the development stage, sufficient design has been conducted to provide a description of the anticipated process to gain environmental approvals and the most significant environmental issues anticipated for each project. The two projects, the Floodway Expansion and the Ste. Agathe Detention Structure have been considered separately. From an assessment perspective, the Floodway expansion has been separated into two projects, the "Wet" Floodway and the Floodway expansion project.

This section describes the anticipated Regulatory Framework associated with the Federal and Provincial approval process and a description of the biophysical issues and impacts associated with each project. From a biophysical perspective, the impacts will be primarily related to aquatic and groundwater issues. These areas are therefore the focus of this Progress report. A discussion of terrestrial, vegetation, heritage and other areas that will be impacted to a lesser degree will be required as a part of an Environmental Impact Assessment, and will be discussed in the final report. Socio-economic issues have been considered separately in Section 4.0.

3.2 Regulatory Framework

Under the Environment Act (Manitoba), all projects in Manitoba of environmental significance will require an environmental licence to be constructed and/or operated. According to Manitoba Regulation 164/88, under the Act, Flood Control Projects which affect an area greater than 100 km^2 are categorized as Class 3 Developments and will require an Environmental Licence. To satisfy the requirements of the licencing process for this type of project, an Environment Impact Statement (EIS) will be required to determine the type and significance of environmental effects of the project. Guidelines will likely formally be issued by Manitoba Environment for the EIS after the project has been initiated.

In addition to the requirements of the Manitoba Environment Act, the project will require an Environmental Assessment under the Canadian Environmental Assessment Act (CEAA). This will be triggered by the requirements associated with Federal Funding, the Fisheries Act or possibly the Navigable Waters Protection Act. Under CEAA, reservoir or water diversion projects of this type are considered likely to have significant adverse environmental effects and will require a Comprehensive Environmental Study.

In addition to the CEAA approval, the requirements of the Federal Fisheries Act as administered by Fisheries and Oceans Canada (DFO) will have to be met. Given the overall significance of the Fisheries Act input to the approvals process, KGS Group and North-South Consultants Inc. met with DFO on February 21, 2001 to review the project scope, the anticipated aquatic impacts and preliminary mitigation alternatives. The assessment of the aquatic issues described below for each project below is based on our assessment to date and additional input received from DFO at the meeting. A follow up meeting is planned with DFO when the project arrangements are better defined.

In the early planning stages of the environmental assessment, the harmonization of the various environmental assessment processes needs to be considered if the environmental effects of the project are to be assessed in an effective manner. In this case, when a project requiring a Comprehensive Study under CEAA is also subject to assessment within another jurisdiction, (i.e. the Environmental Act (Manitoba)) activities should, to the extent that this is possible, be co-ordinated to avoid unnecessary duplication and delays. This approval process harmonization will have to be resolved early in the project initiation phase and will apply to either project.

Public involvement will also play an important role at all stages of the assessment. Development of a thorough public involvement plan is being considered as a part of the Socio-economic Assessment of the projects and is discussed in Section 4.0.

3.3 Floodway Expansion

3.3.1 Groundwater Impacts

The most significant impacts associated with the Floodway Expansion will be related to potential changes to the existing groundwater regime. Each of the Floodway expansion options under consideration will have an impact on adjacent groundwater levels and wells to varying degrees. The carbonate aquifer is extensive and underlies the Red River Floodway and adjacent areas and is the prime source of domestic and commercial water supply for most of the Floodway area. Towards the south end of the Red River Floodway, groundwater quality generally does not meet potable requirements, such that water hauling is more common in this area.

In terms of the proposed options considered to expand the capacity of the Red River Floodway, deepening the Floodway will be expected to lower groundwater levels by approximately the amount of Floodway base lowering and will have a greater impact to groundwater levels than widening the Floodway. The "Wet" Floodway will contain a large volume of water during the summer months with potential for recharge of Red River water into the aquifer, which will impact on the water quality in the aquifer.

The hydro-geological impacts associated with each of the Floodway alternatives can be relatively well defined prior to construction and are currently being assessed at a pre-feasibility level in greater detail as a part of this study. Regardless of the anticipated impacts, an extensive monitoring system would be established to define baseline pre-construction conditions and any changes during and after construction. Mitigation of groundwater impacts will include upgrading, or deepening of some wells. For the "Wet" Floodway alternative, some of the wells may require water quality treatment for domestic use. An estimate for mitigation costs will be developed during this study.

3.3.2 Aquatic Considerations

A number of aquatic issues have been identified as a part of the ongoing assessment and input from DFO.

Construction - There will be a significant amount of construction activity at the inlet and outlet to the Floodway for both the "Wet" and "Dry" Floodway expansion schemes. This would initiate some aquatic concerns associated with potential impacts to the Red River in these areas. With good construction practices and attention to isolating the work areas from the river, these concerns should be relatively straightforward to mitigate.

Groundwater – Lowering groundwater levels in the vicinity of the Floodway may affect small local streams near the Floodway that rely on groundwater discharge as a significant component of the overall flow within the streams. This is not anticipated to be a significant impact and will be assessed as a part of the groundwater investigations.

Fish Stranding - The potential to "strand" fish in the existing Floodway channel, or the expanded Floodway channel needs to be investigated. Although fish stranding could and would likely occur at a number of other locations within the flood plain, this could be viewed as an incremental effect of the project. An estimate of the number of fish that enter the existing channel is not currently known. The potential for fish to exit the existing Floodway channel using the pilot channel and low flow outlet is also unknown and should be investigated. Given that this is a relatively small component of the overall system, this is not anticipated to be a significant issue.

Inlet Control Structure - The operation of the existing Floodway Inlet Control Structure and its impact on fish passage is an issue that has never been evaluated. The Inlet Control Structure may presently be a barrier to fish passage when the gates are raised during a flood event and possibly under high flows when the gates are down. The assessment under the Fisheries Act mandate could be considered retroactively or as part of this project. The impact will be primarily during spring spawning periods May to June. Conditions for rare summer flood conditions will likely not be a concern.

To assess the impact, the flow velocities and gate levels at the inlet structure need to be compared to velocities under normal and flood flows along the Red River. This will allow an assessment of the percentage of time that fish passage is currently possible along the Red River and through the inlet control structure. This analysis is currently under way.

3.3.3 "Wet" Floodway

The impact of this Floodway alternative will have similar environmental impacts and concerns as the "Dry" expanded Floodway with regard to construction impacts and the potential for stranding of fish. Water quality impacts associated with the "Wet" Floodway are more substantial and are discussed in Section 3.3.1. Additional aquatic impacts associated with the "Wet" Floodway are described below:

- **Channel Erosion** – Given that the terrestrial vegetation would no longer be present, there is significant potential for erosion of the clay substrate that would be present in the Floodway channel bottom. This would then be deposited downstream.

- **"Lake effects"** – The "Wet" Floodway will be similar to a lake at the downstream end, and more "river-like" at the upstream end. The large and fairly stagnant water body may produce impacts such as algal blooms, impoundment of suspended sediment, and concentration of contaminants such as phosphorus and nutrients.

- **Sedimentation** – The "Wet" Floodway impoundment is likely to cause the settling of suspended sediment resulting in a small accumulation of sediment in the bottom of the Floodway channel. Although the total sediment load to the Red River would be unchanged, its distribution on a year to year basis would need to be assessed.

- **Flows in Winnipeg** – Diverting flows into the "Wet" Floodway during its summer operation, for the purpose of maintaining a base flow through the Floodway, will reduce the flow in the Red River in Winnipeg. The impacts of the decreased flows and water levels in Winnipeg during low flow periods are unknown at this time, but are of concern.

In general, the aquatic impacts associated with the "Wet" Floodway scheme will be more substantial than the "Dry" Floodway. These will require more rigorous assessment if the "Wet" Floodway moves forward as an attractive alternative.

3.4 Ste. Agathe Detention Structure

3.4.1 General

Implementation of the Ste. Agathe Detention Structure involves the construction of a river control structure and an earth dam across the Red River just upstream of Ste. Agathe. Under flood conditions greater than the 1997 flood magnitude, water levels will be increased by up to 9 ft above natural conditions upstream of Ste. Agathe. The impacts of the changed water levels are primarily Socio-economic and are described in Section 4. The aquatic community on the Red River and a number of smaller watercourses will be substantially impacted by the structure and it's operation. These include the Rat River, the Marsh River, and Tourand Creek.

3.4.2 Potential Impacts and Mitigation

Based on our assessments to date and discussion with DFO, the most significant aquatic impacts, will be:

- Development of potential barriers to upstream and downstream fish passage on the Red, Marsh and Rat Rivers, and Tourand Creek.

- Loss of habitat at the structure location. Removal of the meander bend for construction of the Red River Control Structure represents a loss of fish habitat in the Red River. It is unlikely that this magnitude of loss would be considered acceptable and would require compensation of the fish habitat that would be lost. This would be feasible at an increased cost to the project. This impact could be mitigated if the Control Structure were constructed on a straight part of the river.

- Diversion of flood flows to the Red River from the Rat, and Marsh Rivers

- Diversion of flows from the Marsh and Red Rivers and Tourand Creek to the Rat River for a wide range of flow conditions

A number of potential impacts have been identified in the design process for the Ste. Agathe project. Since the design is at a pre-feasibility level of development, it is premature to have fully assessed the impacts of the project or to have developed mitigation methods to accommodate them. Based on the preliminary feedback from DFO and our internal assessment, a number of modifications to the detention structures have been initiated to mitigate or eliminate aquatic habitat impacts. These include:

- Elimination of the rollway crests (fish passage barrier) at two of the six spillway bays for the Red River control structure. This change was made for a number of reasons including facilitating fish passage, the need to eliminate low-level backwater effects upstream of the structure and to increase the overall capacity of the structure. In addition to enhancing fish passage, the low-level bays will facilitate navigation.

- Removal of the culvert control structure on the Rat River. A low level control structure is now considered in the plan for the Rat River control structures. This will allow fish passage through the dam at the Rat River. No control structure has been provided for the Marsh River, as it is a tributary of the Rat River and is an ephemeral stream with less affected habitat.

As described in Section 2.2, the Ste. Agathe Detention Structure is a complex scheme, which considers diversion of flows from the Red River, Marsh River and Rat River at varying flow frequencies. The most significant aquatic issues associated with fish passage and loss of habitat have been considered in the development of the current scheme. Should the project proceed to advanced levels of design, it is apparent that considerable additional effort will be required to define the nature of the impacts, to evaluate mitigation alternatives and to work with DFO through the definition of compensation, if any.

4.0 SOCIO-ECONOMICS STUDIES

4.1 INTRODUCTION

The scope of this study includes socio-economic analysis to identify impacts, issues, and means to improve both concepts of flood protection. Section 4 of this report summarizes the current status and conclusions of these studies. It has been organized into the following sections:

- **Socio-Economic Indicator Analysis:** describes the socio-economic study area, the comparative effects of the alternatives being considered, and the quantitative and qualitative indicators used to assess impacts.

- **Compensation Analysis** describes the event damage, including legal and property rights issues associated with the alternatives, and property value loss.

- **Recreational Opportunities** reviews the initial conclusions on the potential for recreational opportunities that might enhance the value of either alternative.

- **Public Participation Planning** reviews the needs and considerations of public participation, the current mechanisms that are being assessed, the implications these alternatives might have on consultation.

4.2 SOCIO-ECONOMIC INDICATOR ANALYSIS

Study area definition

The socio-economic study area encompasses the region within the Red River flood zone from the Canada – U.S. border north to Lake Winnipeg. For the purposes of this study, the area has been broken into four impact zones:

- **Zone 1**: Upstream of Ste. Agathe Detention Structure;
- **Zone 2**: Ste. Agathe Detention Structure to Floodway Inlet;
- **Zone 3**: Winnipeg and Surroundings;
- **Zone 4**: Downstream of Floodway Outlet.

The zones represent areas that would be impacted differently by the construction and operation of the proposed flood control alternatives. Table 4.1 lists the municipalities and some basic socio-economic characteristics of each zone. The comparative impacts of the flood control alternative on each zone are considered in the following section.

Comparative Effects of Alternatives

The socio-economic impacts of any flood control measure are directly related to the degree of protection and flooding it affords. Hence the first step in assessing a flood control measure's socio-economic impact is understanding its protection and flooding effects. Considerable effort was directed to this activity in relation to developing a framework for understanding first order effects. The framework that emerged and is used below accounts for the following factors deemed to be important in understanding and comparing the effects of the alternatives:

- **Existing flood protection as a baseline for comparison.** The proposed alternatives will add to the degree of protection and reduce the level of flooding that occurs under the existing floodway and dike system. The contributions of the proposed control measures are best understood by comparing their protection and flooding levels with those of the existing flood control system.

- **Similarities/Differences of proposed alternatives.** Each alternative offers particular levels of protection and flooding. It is important to understand the similarities and differences of effects in order to compare and evaluate the alternatives; which is the ultimate goal of this study.

- **Flood event differences**. The severity of the flood event will have a significant bearing on the degree of protection and flooding associated with each alternative. More importantly, it will influence the comparative effects of the alternatives. Five flood events are examined, ranging from the 1 in 100 year level, which is similar to the 1997 flood, to the 1 in 1000 year flood.

- **Impact zone differences**. The effects of the alternatives can be substantially different within and between the four impact zones. This has a key influence on the comparative socio-economic impacts.

Table 4.1: Study Area Socio-Economic Characteristics

		Affected Communities	Population 1991 Census	Population 1996 Census	Number of private occupied residences 1996 Census	Avg value owned occupied residences 1996 Census	Number of Census Farms 1996 Census
4	Downstream of Floodway Outlet	100% RM of St. Clements	27,109	28,541	10,195	$106,234	579
		100% RM of St. Andrews					
		100% Town of Selkirk					
3	Winnipeg and Surroundings	100% City of Winnipeg	624,693	628,634	249,395	$96,884	193
		100% RM of E. St. Paul					
		100% RM of W. St. Paul					
2	Ste. Agathe Detention Structure to Floodway Inlet	100% RM of Springfield	28,130	30,801	9,671	$111,881	1,220
		100% RM of Tache					
		90% RM of Ritchot					
		60% RM of MacDonald					
		10% RM of Hanover					
		100% Town of Niverville					
1	Upstream of Ste Agathe Detention Structure	100% RM of Rhineland	26,609	28,498	8,673	$93,507	2,174
		100% RM of Montcalm					
		100% RM of Franklin					
		100% RM of DeSalaberry					
		100% RM of Morris					
		90% RM of Hanover					
		40% RM of MacDonald					
		10% RM of Ritchot					
		100% Town of Morris					
		100% Town of Emerson					
		100% Village of St. Pierre-Jolys					
		100% Roseau River #2 First Nation					

Note: The socio-economic study area includes areas that would not experience direct flooding under any scenario. 100% of all potentially impacted RMs have been included because flood event response may affect the entire municipality.

Some RMs have been split between Zone 1 and Zone 2 to account for the fact that portions of the municipality lie upstream of the proposed Ste. Agathe Detention Structure while other portions lie downstream.

Table 4.2 compares the effects on the four impact zones of the Ste. Agathe Detention Structure and the Floodway Expansion to the existing Floodway for the five flood events examined in this study. Table 4.3 compares the effects of the Ste. Agathe Detention Structure to the effects of the Floodway Expansion for each zone. Key points of these comparisons are presented below.

Zone 1: Upstream of Ste. Agathe Detention Structure

- Under existing conditions, this zone is protected to approximately the 1 in 100 year flood. Larger floods would exceed the design capacity of the current flood control measures.

- The Floodway Expansion would result in a reduced level of flooding compared to the existing Floodway in this zone for floods between approximately 1 in 90 years and 1 in 500 years.

- At the 1 in 90 year flood level, flooding levels would be the same in this zone for both the Ste. Agathe Detention Structure and Floodway Expansion.

- The Ste. Agathe Detention Structure creates backwater effects and project induced incremental flooding in this zone for flood events exceeding the 1 in 90 year level. A backwater effect is not present under the 1 in 90 year flood.

Zone 2: Ste. Agathe Detention Structure to Floodway Inlet

- This zone is currently protected to approximately the 1 in 90 year flood level. Floods of greater magnitude would exceed the design of the current flood control measures. Parts of this zone can experience backwater effects with the operation of the existing Floodway.

- In the event of floods larger than the 1 in 90 year flood, the Ste. Agathe Detention Structure would be operated to maintain flood depth and distribution at approximately the 1 in 90 year level. This results in additional flood protection throughout the zone over existing conditions.

Table 4.2: Ste Agathe and Floodway Expansion Options Compared to the Existing Floodway

	flood frequency	Existing Floodway	Ste Agathe Detention Structure		Floodway Expansion		
		Comments	Comparison	Comments	Comparison		Comments
Upstream of Canada-U.S. Border	1:90	Protected to Design Level	=		1:500	1:1000	
	1:200	Design Level protection breached	☒	**Backwater Effect[1]**	=	=	
	1:300	Design Level protection breached	☒	**Backwater Effect**	=	=	
	1:500	Design Level protection breached	☒	**Backwater Effect**	=	=	
	1:1000	Design Level protection breached	☒	**Backwater Effect**	=	=	
Zone 1 Upstream of Ste. Agathe Detention Structure	1:90	Protected to Design Level	=		1:500	1:1000	
	1:200	Design Level protection breached	☒	**Backwater Effect[1]**	=	=	
	1:300	Design Level protection breached	☒	**Backwater Effect**	=	=	
	1:500	Design Level protection breached	☒	**Backwater Effect**	=	=	
	1:1000	Design Level protection breached	☒	**Backwater Effect**	=	=	
Zone 2 Ste. Agathe Detention Structure to Floodway Inlet	1:90	Protected to Design Level	=		1:500	1:1000	
	1:200	Design Level protection breached	☑	↑ duration, levels at Existing Floodway 1:90	= ☑	= ☑	If changes to operating rules made
	1:300	Design Level protection breached	☑	↑ duration, levels at Exisiting Floodway 1:90	☑	☑	
	1:500	Design Level protection breached	☑	↑ duration, levels at Exisiting Floodway 1:90	=	=	
	1:1000	Design Level protection breached	☑	↑ duration, levels at Exisiting Floodway 1:90	☒	=	**Backwater Effect[1]**
					=	☒	**Backwater Effect**
Zone 3 Winnipeg and Surrounding	1:90	Protected to Design Level	=		1:500	1:1000	
	1:200	Design Level protection breached	☑		=	=	
	1:300	Design Level protection breached	☑		☑	☑	
	1:500	Design Level protection breached	☑		☑	☑	
	1:1000	Design Level protection breached	☑		☑	☑	
					=	☑	
Zone 4 Downstream of Floodway Outlet	1:90	Protected to Design Level	=		1:500	1:1000	
	1:200	Not Available [2]		Not Available [2]	=	=	Not Available [2]
	1:300	Not Available		Not Available			Not Available
	1:500	Not Available		Not Available			Not Available
	1:1000	Not Available		Not Available			Not Available

Legend: ☑ better than
= equal to
☒ worse than

Notes: (1) Backwater effect related to either the Ste Agathe or Floodway Expansion projects could result in the requirement for incremental damage compensation
(2) Projected impacts in this zone continue to be investigated but are unavailable at this time.
Depth: depth of flooding
Duration: length of time of flooding
Distribution: lateral extent of flooding

Table 4.3: Ste Agathe and Floodway Expansion Options Compared to Each Other

	flood frequency	Ste Agathe Detention Structure		Floodway Expansion		
		Comparison	Comments	1:500	1:1000	Comments
Upstream of Canada-U.S. Border	1:90	=		=	=	
	1:200	☒	↑ duration, distribution, depth, **Backwater Effect** [1]	☑	☑	
	1:300	☒	↑ duration, distribution, depth, **Backwater Effect**	☑	☑	
	1:500	☒	↑ duration, distribution, depth, **Backwater Effect**	☑	☑	
	1:1000	☒	↑ duration, distribution, depth, **Backwater Effect**	☑	☑	
Zone 1 Upstream of Ste. Agathe Detention Structure	1:90	=		=	=	
	1:200	☒	↑ duration, distribution, depth, **Backwater Effect** [1]	☑	☑	
	1:300	☒	↑ duration, distribution, depth, **Backwater Effect**	☑	☑	
	1:500	☒	↑ duration, distribution, depth, **Backwater Effect**	☑	☑	
	1:1000	☒	↑ duration, distribution, depth, **Backwater Effect**	☑	☑	
Zone 2 Ste. Agathe Detention Structure to Floodway Inlet	1:90	=		= ☑	= ☑	Changes to Operating Rules required
	1:200	☑	↑ duration	☑	☑	Changes to Operating Rules required
	1:300	☑	↑ duration	☒	☒	
	1:500	☑	↑ duration	☒	☒	**Backwater Effect**[1]
	1:1000	☑	↑ duration	☒	☒	**Backwater Effect**
Zone 3 Winnipeg and Surrounding	1:90	=		=	=	Possible Benefits if Operating Rules Changed
	1:200	=		=	=	Possible Benefits if Operating Rules Changed
	1:300	=		=	=	
	1:500	=		=	=	
	1:1000	☑	if 1:500 design Floodway, otherwise equal to	☒	=	
Zone 4 Downstream of Floodway Outlet	1:90	=		=	=	
	1:200		Not Available [2]			Not Available [2]
	1:300		Not Available			Not Available
	1:500		Not Available			Not Available
	1:1000		Not Available			Not Available

Legend: ☑ better than
= equal to
☒ worse than

Notes: (1) Backwater effect related to either the Ste Agathe or Floodway Expansion projects could result in the requirement for incremental damage compensation

(2) Projected impacts in this zone continue to be investigated but are unavailable at this time.

Depth: depth of flooding

Duration: length of time of flooding

Distribution: lateral extent of flooding

- The Floodway Expansion would provide the same "state-of-nature" water levels as the existing Floodway, up to approximately the 1 in 90 year flood. At greater floods, increases in water level above the state-of-nature would be required for the existing Floodway. For the Floodway Expansion, however, water levels would not exceed the state of nature until the river flow exceeds approximately a 1 in 250 year flood magnitude (or 1 in 700 year flood in the case of the 1 in 1000 year Floodway Expansion). At the 1 in 500 year flood magnitude and greater (or 1 in 1000 year for the larger channel), the Floodway Expansion would cause water levels in this zone that are approximately equal to the existing Floodway.

- For floods between approximately 1 in 90 years and approximately 250 year return periods, the Floodway Expansion can provide increased flood protection to this zone compared to the existing Floodway. For floods beyond the 1 in 90 year magnitude, the Ste. Agathe Detention Structure provides greater flood protection than the Floodway Expansion".

Zone 3: Winnipeg and Surrounding Areas

- This zone is currently protected by the existing Floodway and a dike system to approximately the 1 in 90 year flood level. For floods greater than the 1 in 90 year level the Ste. Agathe Detention Structure and the Floodway Expansion provide greater protection.

- For the 1 in 90 to the 1 in 500 year flood levels the Ste. Agathe Detention Structure and Floodway Expansion provide approximately the same level of flood protection to this zone. At the 1 in 500 or the 1 in 1000 year level, depending upon the final design criteria, the design capacity of the Floodway Expansion would be exceeded while the Ste. Agathe Detention Structure would still provide flood protection.

- For the 1 in 90 year and 1 in 200 year floods, it may be possible to alter the Floodway operating rules so that the Floodway Expansion provides somewhat improved flood protection compared to the Ste. Agathe Detention Structure.

Zone 4: Downstream of Floodway Outlet

- Impacts in this zone associated with both alternatives continue to be examined.

- Based on the current level of knowledge, it appears that the Ste. Agathe Detention Structure provides equal or greater levels of flood protection to this zone compared to the Floodway Expansion.

Quantitative Socio-Economic Indicators

As noted previously, the major issue in an analysis of socio-economic impacts of flood control measures is the flooding and flood protection associated with each alternative. The differences between the distribution, depth and duration of flooding for each flood event affects the degree of socio-economic impacts. A simple damage-dollar value, though useful for indicating the severity of a particular flood and estimating compensation figures, does not provide a complete picture of socio-economic impacts due to flooding. In order to provide a more complete understanding of the impacts associated with each alternative, this analysis takes an indicator approach to assessing the quantitative socio-economic impact of flooding in the study area. Flooding and flood protection for each alternative are compared to the existing condition for each of five flood events. Five types of indicator have been selected. A brief description of each indicator follows.

- **Impacted Residences** This is the most prominent, widespread and easily understood measure of socio-economic impacts. It portrays the number of residences that benefit from increased protection or are damaged by residual or project induced flooding. The number of impacted residences can also be used to estimate the number of people whose residences are directly impacted by flooding.

- **Farms Affected** This indicator estimates the number of flooded farms and the total flooded farm area. Flooding can affect large numbers of farming operations and large areas of farmland that cannot be protected by flood control measures.

- **Transportation** This indicator estimates the length of roads protected and flooded in each scenario.

- **Social Infrastructure** This indicator is represented by the number of churches, schools, hospitals and community halls protected and flooded.

- **Employment** These estimates are based upon the number of commercial and industrial buildings protected and flooded and the employment and work force profiles of the area.

All of these indicators are based to some degree upon engineering models of the extent of flooding and structural, infra-structural and agricultural damages. Preliminary results for population indicators in some zones are available. Although definitive conclusions cannot be drawn at this time, it is apparent that different flood scenarios and flood control options result in different socio-economic impacts in the study area.

Interviews will be conducted during May and June with key persons to solicit input and perspectives about the two flood protection options, including information on quantitative and qualitative socio-economic indicators, comparative effects and recreational opportunities. The "key people" have been defined as community representatives and leaders, and parties and agencies that may have comments about either alternative or relevant information. The results of these interviews will be used to complement the other data sources in the study and provide a more complete understanding of the views that are held in the study area toward the two flood protection options.

Qualitative Socio-Economic Indicators

In addition to having physically related consequences, research has found that flood damage and the threat of it are sources of stress and anxiety for property owners and residents potentially affected by flooding. Stress and anxiety are flood impacts that are not as readily measured as damages to persons and property. Nevertheless, they are typical impacts resulting from flood damage and the perceived threat of damage and can often serve as indicators of the severity of a flood event.

A review of the literature on this topic reveals that, for residents and property owners, primary sources of stress from a flood event are the magnitude of the flood in terms of water level and duration and the associated potential and actual damages to people and property. The frequency of flooding is another direct source of stress. In addition, socio-economic characteristics such as the financial resources, physical health, gender, age and type of property owned by residents can influence the amount of stress and anxiety associated with a given flood event.

Socio-economic research on the 1997 Red River flood found that event response also played a key role in stress and anxiety. Event response activities include pre-flood hydrologic analysis and forecasting, flood preparedness activities, flood response and flood recovery. When carried out effectively, event response can serve to reduce stress and anxiety from a flood event. However, as was the case for some aspects of the 1997 flood, ineffective, poorly designed or poorly implemented response procedures can significantly compound stress.

People engaged in event response and fighting the rising waters are also subject to stress and anxiety during a flood event. Decision-makers and emergency service providers such as municipal officials, provincial agency representatives, federal agency representatives and the staff of non-profit organizations experience stress from the demands of their duties during flood events. Efforts are currently underway to improve management, co-ordination and resources for event response for future flooding in the Red River. Stress and anxiety from future flood events can be reduced to the extent that such improvements are implemented.

Results from the key person interviews will be used to complement these data sources in the study and provide a more complete understanding of the views that are held in the study area toward the two flood protection options.

4.3 COMPENSATION ANALYSIS

Planning and Mitigation Options

Both of the proposed flood control alternatives have the potential to cause project induced flooding in portions of the study area. In the case of the Floodway Expansion, this incremental flooding would take place if the capacity of the channel at the state of nature water level were exceeded. For the Ste Agathe structure, project induced flooding would take place beginning at approximately the 1 in 90 flood and increase with severity of the flood.

Such flooding, irrespective of the project, would be rare and the usual compensation approaches used in the development of water retaining projects might have to be supplemented. In the development of a reservoir, for example, the owner establishes land control or ownership within a "take line". This is accomplished either by purchase of the land or by purchase of flood easements.

In the case of the Manitoba flood protection projects, this would require, as one possibility, government purchase of entire communities and large areas of the most productive agricultural land in the Province. Clearly, this is impractical.

The other alternative, flood easements, raises questions such as intergenerational equity. Project induced flooding will be so rare that compensation to the current generation of land owners may provide little or no benefit to their descendants who may actually experience flooding. Further, because of the infrequency of project induced flooding, the present value of damages would be low and any compensation payment based on this would likely be considered unacceptable.

Another option would be to mitigate project induced damages upfront, and protect communities and individual residences affected by the project to a prescribed level as part of the project cost. This level could be the design flood. Under this mitigation concept, added diking would be needed for both projects, albeit to different extents. Most probably, however, key community ring dikes could be raised as a project cost while others affected by project induced flooding could be paid when damages occur.

Initial Legal Framework – Compensation

Development of flood control projects of the magnitude of those contemplated for Winnipeg require an understanding of the legal concepts that may be in play, particularly in regard to project induced flooding through backwater effects. An initial approach, based on discussions with Manitoba Justice, includes the following understanding of current Manitoba law as it pertains to this matter:

- Obtaining flood easements on a large scale would likely be impractical and is not necessary.

- Under section 12 of The Emergency Measures Act the Minister of Transportation and Government Services has the authority to use private lands for the operation of a flood control work when a state of emergency is declared. Under these conditions the Minister can 'utilize any real or personal property considered necessary to prevent, combat or alleviate the effects of any emergency or disaster.

- The Province would have to pay compensation for incremental damages suffered as a result of exercising the powers granted under section 12. Compensation amounts would be determined on the basis of provincial government guidelines.

- Existing legislation could be amended, if deemed necessary, to enable the lawful operation of either structure under a broader range of situations.

Based on an initial analysis of the current state of Manitoba law, the implications for either project may include:

- Flood easements may not have to be obtained to flood upstream lands during a flood emergency. As such there would be no flood easement capital costs for either project.

- Compensation for incremental project induced damages would have to be paid when an event occurs. This amount would need to be factored into the cost equation for the project cost/benefit analysis.

- Compensation guidelines are the responsibility of the Province of Manitoba. The amount of compensation would correspond closely to the damage estimates produced by the damage models. These estimates, which are currently being developed, are based on existing compensation criteria.

- Due to the sensitive nature of these project induced damages, compensation guidelines may need to be expanded to include damages not currently eligible for compensation. Expanded compensation would need to consider business interruption losses and the expansion or removal of limits on compensation allowances. This could add 10-30% to the compensation amounts for a flood event.

Given the importance of the legal framework to mitigation and compensation requirements of either project, an independent legal opinion is being sought to provide further clarity and understanding to this issue. The results of this opinion will be incorporated into the final report.

Property Value Loss

Loss of property value was an issue raised at public hearings held by the International Joint Commission. Many residents upstream of Ste. Agathe expressed concern that the Ste. Agathe Detention Structure would result in lower property values south of Ste. Agathe due to an increased risk of flooding should the detention structure be operated. Presenters stated that this anticipated loss in property values should be included in the capital cost estimates for the Ste. Agathe structure in order to provide a basis for a fair comparison between it and the Floodway Expansion option.

Preliminary analysis of case studies from other jurisdictions has found that flood-related property value losses can occur in the short term, but are generally not sustained. Properties within 100-year floodplains can experience a loss of value immediately following a flood event. However, the loss in property value typically lasts only for a period of three to five years, after which time the values of properties in the floodplain typically return to, or in some casesexceed, levels for comparable properties outside of the floodplain. Variables that affect the extent and duration of the property value loss include where the property is located in the floodplain, flood history, attributes of the floodplain and, in the U.S. context, flood insurance premiums.

Based on our current assessment and the literature reviewed, we would expect the following points would apply to properties south of Ste. Agathe:

1. Any project induced flooding would be rare, e.g. beyond a 1 in 100 year event;

2. The area south of Ste. Agathe is in the Red River Flood Plain and residents are aware that periodic flooding occurs. Effects of periodic flooding are already reflected in property values, making it difficult to discern any changes in property values attributable to project induced flooding. This does not preclude the possibility that, in the wake of a significant flood, short-term losses in property values may be experienced;

3. In most cases, project induced flooding would be adding to existing flooding rather than creating new flooding.

This assessment suggests that the basis for property loss compensation in conjunction with the Ste. Agathe Detention Structure would be difficult to discern and tied to short term losses.

Results from the key person interviews will be used to complement these data sources in the study and provide a more complete understanding of the views that are held in the study area toward the two flood protection options.

4.4 RECREATIONAL OPPORTUNITIES

The study is examining the potential for incorporating recreational opportunities with the consideration of alternatives, with the objective of identifying opportunities to enhance the value of either project. Over the course of the study, the project team has met with Provincial Government representatives who have been working to identify recreational opportunities that might enhance either flood protection option.

At the present time, the following conclusions can be made with regards to recreational opportunities:

1. Regulation of Red River water levels within the City of Winnipeg appear to offer the most significant recreational benefits compared to development of new recreational facilities with either the Ste Agathe or Floodway expansion alternatives.

2. There appear to be limited recreational opportunities associated with the development of any alternative that includes maintaining water in part or all the Floodway (the wet Floodway).

3. Although recreational opportunities have been identified for both the Ste Agathe and Floodway expansion alternatives, the Floodway expansion provides the greatest number of alternatives and most significant opportunity because of the relative proximity to Winnipeg, the presence of existing recreational facilities and the availability of fill material.

Results from the key person interviews will be used to complement the research being undertaken and solicit comments on the opportunities being examined.

4.5 PUBLIC PARTICIPATION PLANNING

Background

- The SAFE Studies are largely fact-finding, intended to learn more about the engineering, financial, environmental and social aspects of the alternative measures that can be taken to protect Winnipeg from future large scale flooding from the Red River.

- These studies include a component for the planning of public participation

- Various alternative approaches to public participation are available and are to be analysed and the choices narrowed down for future study phases.

- It is assumed that public participation would commence following completion of this phase of work

Considerations

Public participation should encompass the following needs which could be addressed through a simple multi-component process or through multiple staged processes:

- **Public Education and Information-sharing** - elevate the level of understanding in the basin of the alternative projects, their costs, their benefits, the effects on individuals, communities and livelihoods and the behaviour of the Red River.

- **Input to Choice of Alternative** - provide for consultation or collaboration on a decision on which project to build - various levels of Floodway expansion or the Ste. Agathe structure.

- **Input to Operating Rules** - provide for consultation or collaboration on the design or alteration of operating rules for the Floodway or a Ste. Agathe structure.

- **Input to Mitigation and Compensation** - provide for consultation or collaboration on the design and delivery mechanisms for flood mitigation and compensation.

Major portions of the public participation process should be conducted by an independent body. There remains considerable dissatisfaction among residents of the Study area south of Winnipeg with the way in which flood mitigation and compensation were handled in 1997. A government led process could be perceived as lacking independence by some.

The public participation process should be transparent, comprehensive and rigorous given the strong feelings in the Valley and the needs of various approval processes including provincial environmental licensing and the federal environmental assessment requirements. The decisions being taken need to last for the very long term.

Time is an element of considerable importance. Good public participation processes take time. However, allowing significant time to pass before a commitment to a particular project is made carries with it a risk that the sense of urgency for the project may lessen somewhat at all levels. Major commitments to flood protection are more easily achieved when memories of the flood event are still fresh.

University-based research is beginning in the basin on public participation processes for flood protection and mitigation (CURA). While the results of this research will not be available for three or more years, opportunities for mutual support between the two undertakings should be explored and maximized where practicable.

Mechanisms

The following are mechanisms for addressing the public participation needs listed above:

Public Education and Information Sharing

- Education should be seen as a two-way process. One objective should be to improve the understanding of the public regarding the Basin and the projects proposed and their possible operation and effects. Another is to learn from the residents what is important to them and how engineers and planners could more fully meet their needs and alleviate their concerns.

- Two levels of educational effort are possible. One focuses largely on the provision of information through print and the internet and is less consumptive of time and other

resources. The other is more interactive, is more likely to be two-way, and as a consequence, takes longer and costs more. An example would be joint-learning workshops involving project experts and interested members of the public.

Alternative Projects, Mitigation and Compensation

- Decisions which meet the needs of all the interested parties are decisions which will have durability and will not have to be revisited or debated long after they are made. Collaborative processes, which include full consensus models or other multi-stakeholder work-shopping approaches, are a dependable way to ensure that interested parties are satisfied with the process and outcome.

- Consultations, such as traditional public meetings or open houses, are not normally collaborative in nature. They are more liable to be confrontational and less likely to assist in resolving conflicting needs. However, they are less expensive and time consuming than collaborative processes.

- Whether collaborative or more traditional approaches are chosen, the processes could be overseen by the proponents of the project or, alternatively, by a body such as a commission.

- The sequence in which issues are dealt with can be varied. For example, compensation and mitigation issues are high on people's agendas, given their experience in 1997, and it might be desirable to discuss these issues first. This would allow the concerns of the public regarding mitigation and compensation to be resolved before expecting them to express an opinion on which project is preferable. Alternatively, the project choice could be dealt with first, delaying full consideration of mitigation and compensation issues until project details were fully known.

Timing

- Processes of consultation are much less time-consuming than collaboration. A full consensus-building process would take 2 years. Other collaborative, multi-stakeholder processes could be somewhat shorter. Open houses and public meetings could potentially be completed in a year or less.

Independence and Commission Choices

There are a number of choices available for ensuring that an appropriate level of independence is achieved in public participation.

Neutral Third Parties

- Consultants with facilitation and dispute resolution skills and acceptable to all highly interested parties would be in a position to manage public participation processes.

Blue Ribbon Commission

- The appointment of a blue ribbon commission implies that the commission would make recommendations and would have direct engagement in substantive outcomes
- The names of the appointees would add credibility to outcomes and to some extent, to the process they manage.
- The process could be either of a consultative or a collaborative nature.
- Independent Commission as Process Managers
- This group of appointees would co-ordinate or oversee a consensus-building or other collaborative process
- The commission would help to ensure the credibility of process
- This version of the commission would not make recommendations but would simply forward those that emerged from the process.

Authority for a Commission

- A joint federal – provincial panel under environmental assessment legislation
- Use of the Manitoba Clean Environment Commission
- Use of other provincial or federal legislation

Project Choices - Influences on Public Participation

- **Scenario 1 - Formal consideration of both a Ste. Agathe project and an expansion of the Floodway:** the cost, time required and complexity of public participation is significant. There would need to be strong engagement of residents from Lake Winnipeg to the U.S. Border.

- **Scenario 2 - Formal consideration of more than one Floodway expansion option:** the cost, time required and complexity of public participation is reduced. A smaller number of people from a smaller area would need to be intensively engaged.

Public Participation Planning Product

There is recognition by the Steering Committee that there will need to be an education component and that input is required on all substantive issues. There is also agreement that the substantive issues will need to be dealt with, at least in part, through an independent mechanism. While Steering Committee members note the need for a timely conduct of the public participation process, there is also an understanding that investment in good process up front may shorten later stages of project development.

The strongest public participation approach is an integrated process. This process would include:

1. A mutual learning component which includes excellent information on the proposed projects and on the Red River and its behaviour. This component also is interactive so that all participants learn in the process. In other words, the deliverers of the project information learn as much as the intended recipients. It would be accomplished in the following way:

    - Some initial information would be provided before the collaborative process begins. That information should be broadly shared with all potentially interested parties. When the collaborative process is underway, the formal information dissemination continues to the broader public while a more informal but strong mutual learning experience begins with the group of people directly engaged in the process.

2. A collaborative component that deals with all substantive issues. In this case, those issues are the selection of the flood protection project and the design and delivery of mitigation and compensation as well as operating rules for the selected structures.

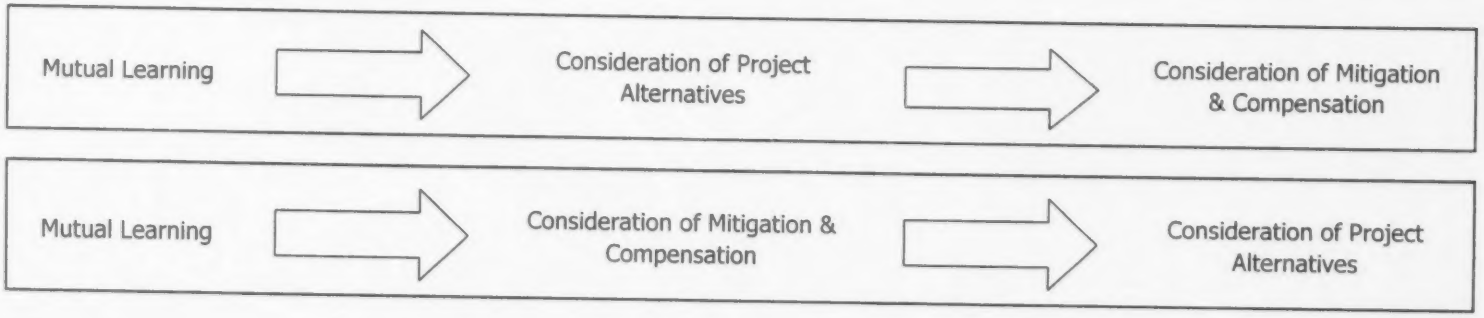
3. A follow-up process that ensures agreements reached and commitments made are realized.

By July 2001, the Steering Committee will be in a position to advance clear alternative public participation options for both project choice scenarios. Included in these options will be choices of delivery mechanisms for public education and information sharing, choice between consultative and collaborative processes to deal with the substantive issues, choice with regard to the sequencing of the discussions, choices on the duration of the processes and, finally, on dealing with the question of independence.

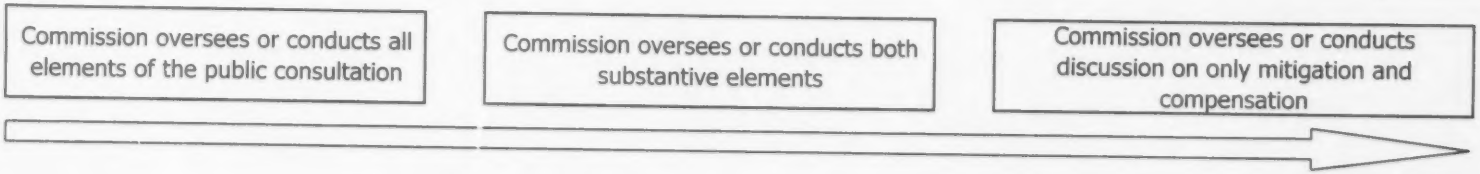
A summary of public participation choices is presented in Figure 4.1.

FIGURE 4.1: SUMMARY OF PUBLIC PARTICIPATION CHOICES

Sequence

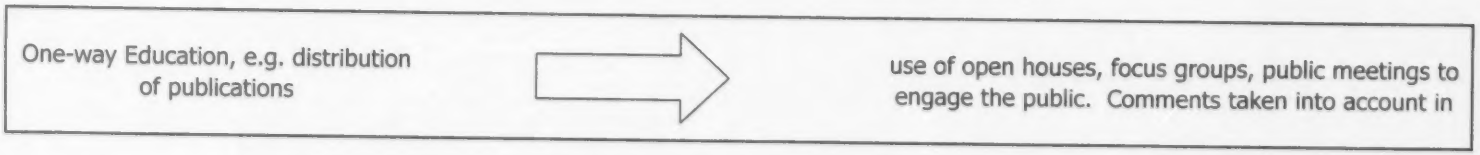


Independence

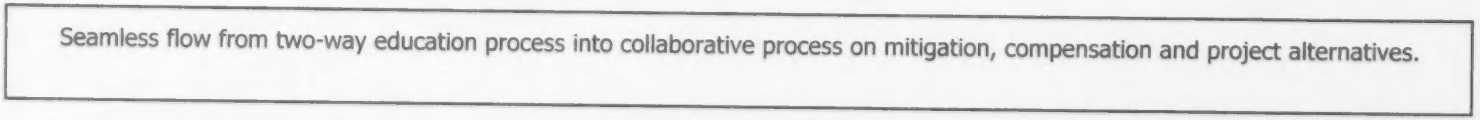

Commission oversees or conducts all elements of the public consultation
Commission oversees or conducts both substantive elements
Commission oversees or conducts discussion on only mitigation and compensation

Nature of Processes

Involvement - lower cost, shorter time, less effective


One-way Education, e.g. distribution of publications
use of open houses, focus groups, public meetings to engage the public. Comments taken into account in

Collaboration - higher cost, longer time required, more effective


Seamless flow from two-way education process into collaborative process on mitigation, compensation and project alternatives.

5.0 ORGANIZATION FOR IMPLEMENTATION OF MAJOR PROJECT

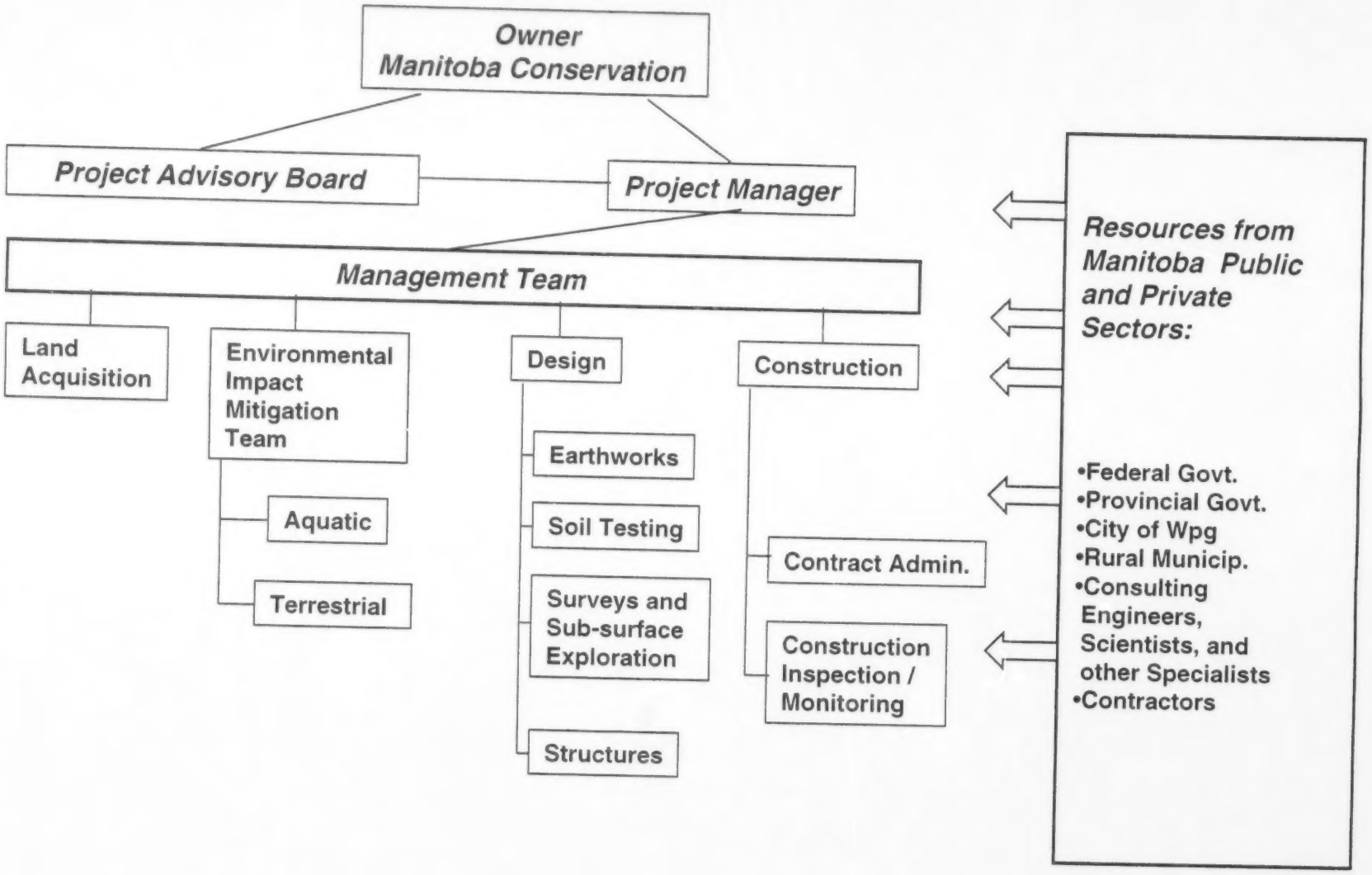
It is clear that implementation of a project of the magnitude of either the Floodway Expansion or the Ste. Agathe Detention Structure would require a concerted effort by a group that would be devoted full time to the task. The organizational structure that is envisaged as the most efficient for executing the work is shown in Figure 5.1. The figure shows an organizational structure that is similar to the one used during the original construction of the Floodway. At that time, a separate division of the provincial government was established for the sole purpose of executing the Floodway construction.

The organization of the structure that would be required to complete a major project could be made up in a number of ways. It could range from, on one extreme, a design/build agreement with a contractor or group of contractors, to a more traditional composition drawing from government staff, and using consultants and contractors as appropriate. The latter approach was adopted in the Floodway Division of the 1960's. An intermediate option would be assignment of specific management, design, and/or construction supervision responsibilities to capable companies in the private sector. The design/build approach is not favoured because it would result in an unacceptable loss of project control by the owner.

The best course of action would commence with the selection of the philosophy on project organization that is best for the owner (primarily a decision on the approach of mixing the public sector involvement with that of the private sector). It is proposed thatthe government would be assisted in this project definition period by a "Project Advisory Board". This Board would be established at the outset of the work. It would then continue through the execution of the project, acting as an overall vetting system for critical technical and administrative issues. The Board is envisaged to consist of approximately 8 recognized experts covering the fields of engineering design, construction, contract administration, and environmental science.

Models that would be based on the overall organizational structure shown in Figure 5.1 will be developed in the second half of this study, and will provide more details on probable staff numbers and options of composing the team(s) from the public and/or public sectors. This would form a basis for the planning and decisions that the Project Advisory Board would carry out in advising and assisting the various levels of government.

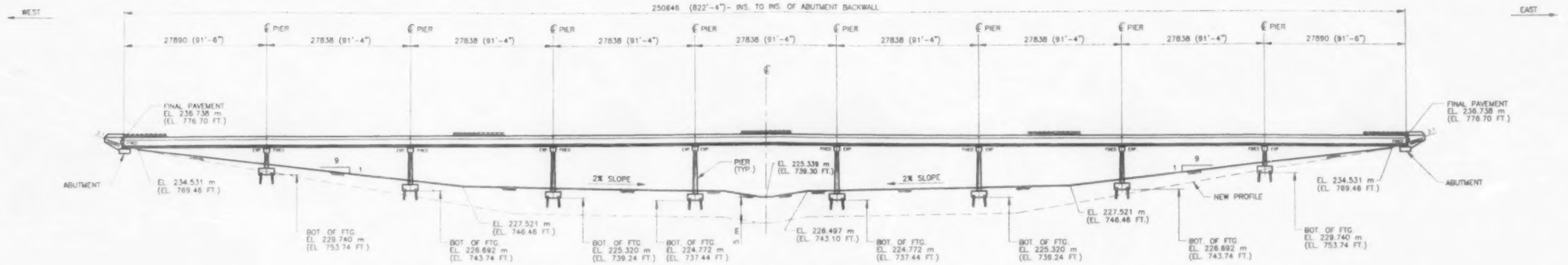
Figure 5.1 - Proposed Structure for Implementation of Major Flood Protection Project for Winnipeg



6.0 ON-GOING STUDIES

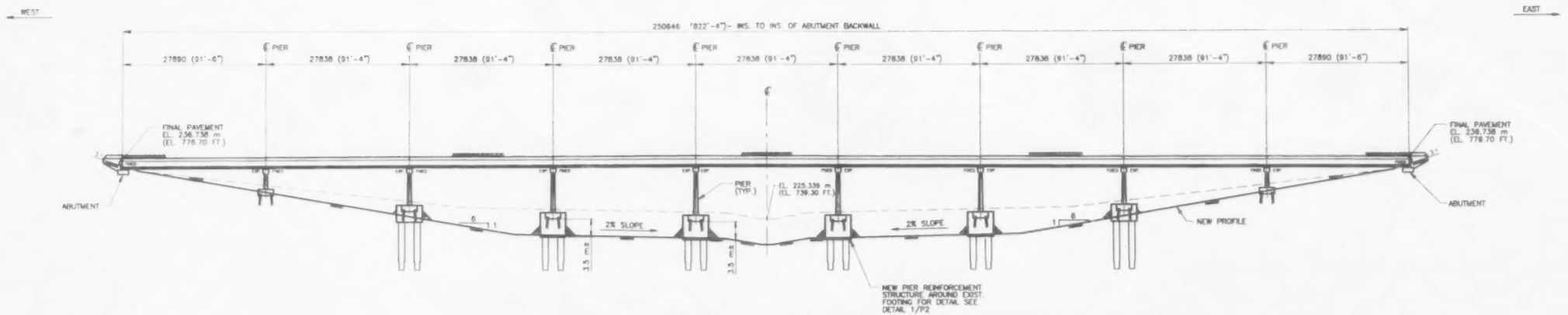
The work plan summarized in Appendix A is being methodically carried out. All tasks will be completed and reported at the end of the study.

PLATES



A ELEVATION – BRIDGE ON ST. MARY'S ROAD – EXISTING

SCALE: 1:400 (24" X 36" SHEET)
1:800 (11" X 17" SHEET)



B ELEVATION – BRIDGE ON ST. MARY'S ROAD – DEEPENED CHANNEL

SCALE: 1:400 (24" X 36" SHEET)
1:800 (11" X 17" SHEET)

EXIST. AREA
1509.3061 m²
NEW AREA
2305.8066 m²

0 8 16 24 32m
SCALE: 1:400 (24" X 36" SHEET)
1:800 (11" X 17" SHEET)

FLOODWAY HIGHWAY BRIDGES

BRIDGE NAME	LOCATION IN FEET UPSTREAM OF OUTLET STRUCTURE	ELEVATION OF LOWER CHORD OF BRIDGE DECK	APPROXIMATE ELEVATION OF TILL (m)	UNDERSIDE LOWEST PIER FOOTING (m)
ST. MARY'S ROAD	149,040	771 ft. (235.001 m)	218.0	224.772
PTH 59 SOUTH	125,280	769 ft. (234.391 m)	216.5	223.484
TRANS CANADA	101,140	770 ft. (234.696 m)	216.5	222.956
PTH 15	81,090	773.5 ft.(235.763 m)	218.0	222.870
PTH 59 NORTH	50,380	769 ft. (234.391 m)	219.0	222.047
PTH 44	1,940	756 ft. (230.429 m)	220.5	219.608

Manitoba CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

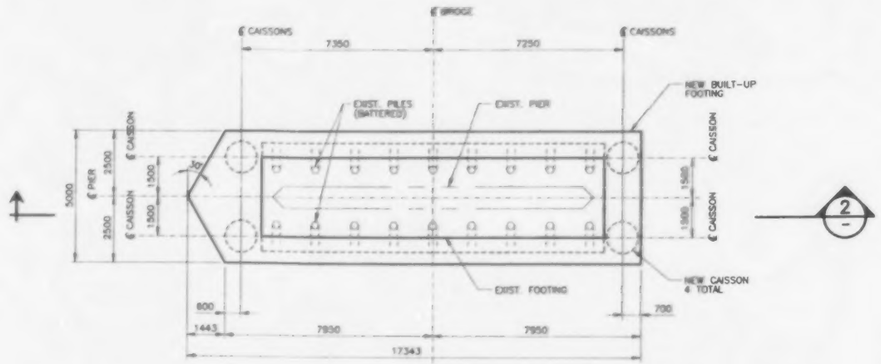
TYPICAL HIGHWAY BRIDGE MODIFICATION

PLATE 1

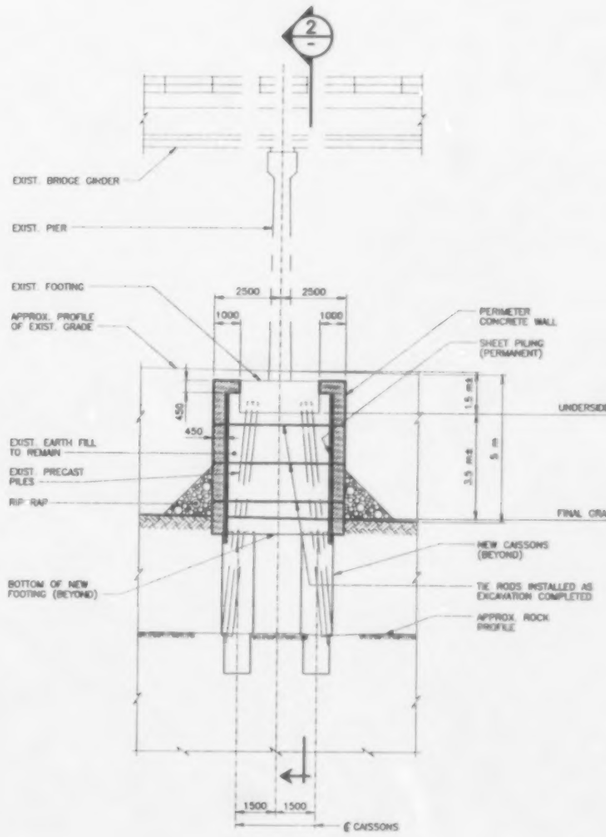
INTERIM REPORT - MAY 2001

KGS GROUP

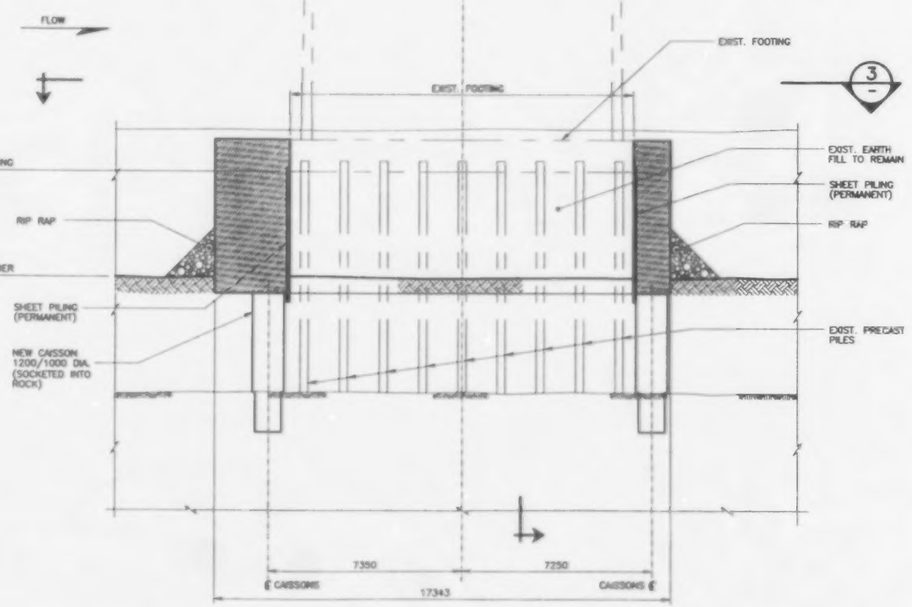
KGS FILE NO. 00-311-07-35-Filter0.dwg
24"x36" PLOT SCALE 400



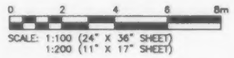
3 SECTIONAL PLAN
SCALE: 1:100 (24" X 36" SHEET)
1:200 (11" X 17" SHEET)



1 SECTION – TYPICAL PIER REHABILITATION
SCALE: 1:100 (24" X 36" SHEET)
1:200 (11" X 17" SHEET)



2 SECTION
SCALE: 1:100 (24" X 36" SHEET)
1:200 (11" X 17" SHEET)



SCALE: 1:100 (24" X 36" SHEET)
1:200 (11" X 17" SHEET)

Manitoba CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

TYPICAL "RETROFITS" TO BRIDGE

PLATE 2
INTERIM REPORT–MAY 2001

KGS GROUP

KGS FILE NO. 00-311-07-25-PL02rev0.dwg
24"x36" PLOT SCALE 400

ST. MARYS ROAD

HIGHWAY NO. 59 SOUTH

DAWSON ROAD

TRANS. CANADA HIGHWAY NO. 1

TEST PIT

ELEVATION IN FEET

800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630

FLOODWAY INLET

RED RIVER

CLAY

EXISTING BOTTOM OF SLOPE

EXISTING TOP OF PILOT CHANNEL

EXISTING PILOT CHANNEL INVERT

TILL

BEDROCK

1500+00
1400+00
1300+00
1200+00
1100+00
1000+00

M2S FILE NO.: 00-311-07.30-PLOWDK0.DWG
24"x36" PLOT SCALE: 4000'

TRANS. CANADA HIGHWAY NO. 1

TEST PIT

HIGHWAY NO. 15 (DUGALD ROAD)

SPRINGFIELD ROAD

HIGHWAY NO. 59 NORTH

BIRDS HILL ESKER

CLAY

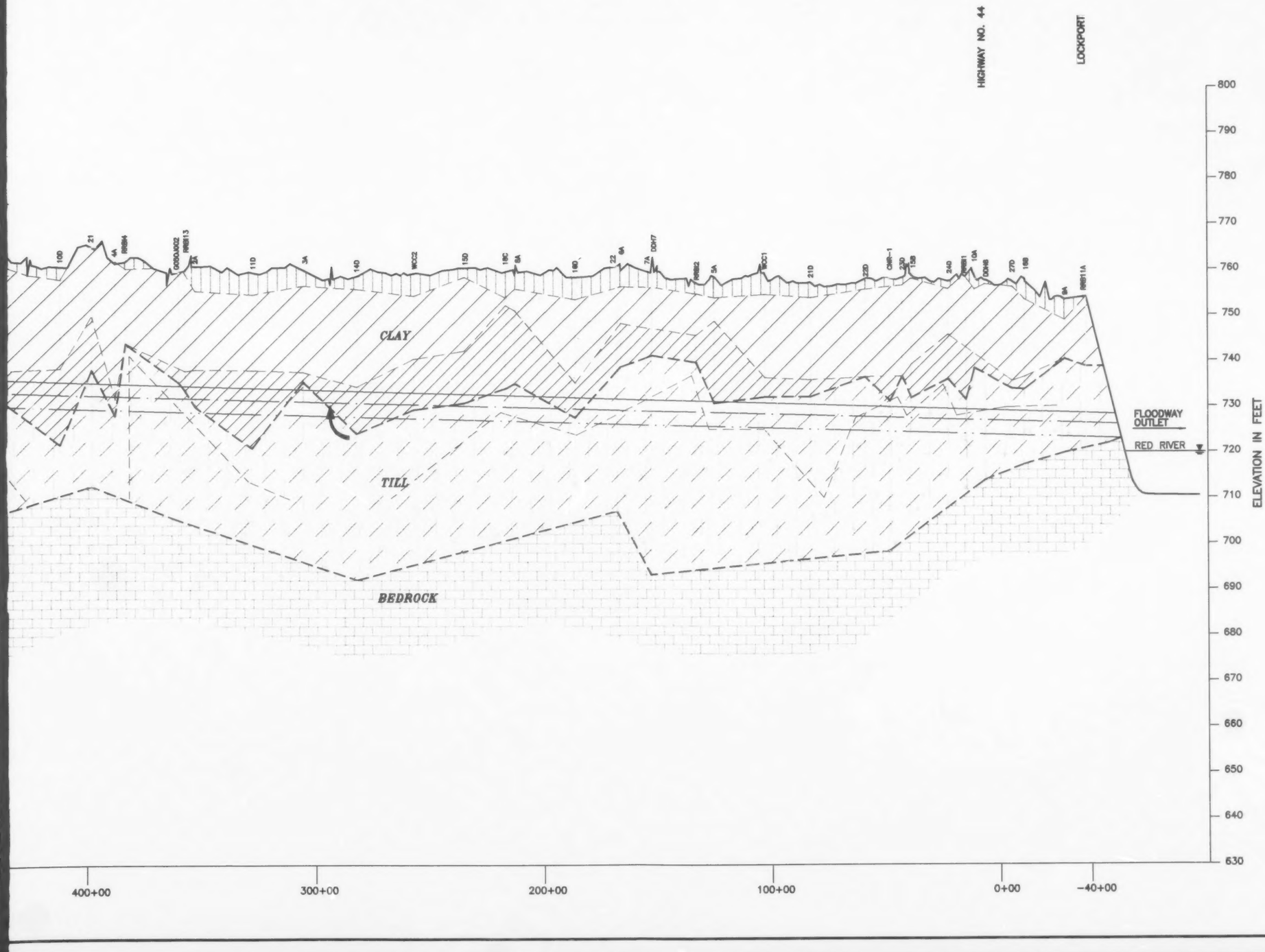
SAND AND GRAVEL

TILL

BEDROCK

1000+00 900+00 800+00 700+00 600+00 500+00 400+00

CHAINAGE IN FEET



LEGEND

- GROUND SURFACE
- EXISTING BOTTOM OF SLOPE
- EXISTING TOP OF PILOT CHANNEL
- EXISTING PILOT CHANNEL INVERT
- APPROXIMATE AREAS WHERE GROUNDWATER DISCHARGE (100 GPM OR GREATER) WAS NOTED DURING FLOODWAY CONSTRUCTION (RENDER,1970)
- VARIABLY TEXTURED FINE SEDIMENTS (SILTY AND SANDY CLAY, SANDY SILT, ORGANIC SILTS AND CLAY)
- BROWN CLAY
- GREY CLAY
- GLACIAL OUTWASH SAND AND GRAVEL
- UNCEMENTED GLACIAL TILL
- CEMENTED GLACIAL TILL
- CARBONATE BEDROCK

NOTES:

1. DATA USED TO COMPILE SECTION INCLUDES:
   - HOBSON (1964) HAMMER SEISMIC SURVEY
   - GWDRILL DATABASE
   - MANITOBA WATER RESOURCES WELL DATABASE
   - MANITOBA DEPARTMENT OF AGRICULTURE AND CONSERVATION WATER CONTROL AND CONSERVATION BRANCH DRAWING FILE NUMBERS 11-5-1067,11-5-1137,11-5-1516,11-5-1287.
2. BOREHOLES USED TO PRODUCE SECTION ARE LOCATED WITHIN 300ft OF FLOODWAY CENTERLINE, WITH EXCEPTION OF CNR-1 (354ft W), 21 (472ft W) AND 13 (590ft W)
3. CURRENT BEDROCK PIEZOMETRIC LEVELS NEAR THE FLOODWAY CENTERLINE VARY FROM ELEVATIONS NEAR THE TOP OF THE EXISTING PILOT CHANNEL TO ELEVATIONS NEAR THE EXISTING BOTTOM OF SLOPE.

Manitoba CONSERVATION

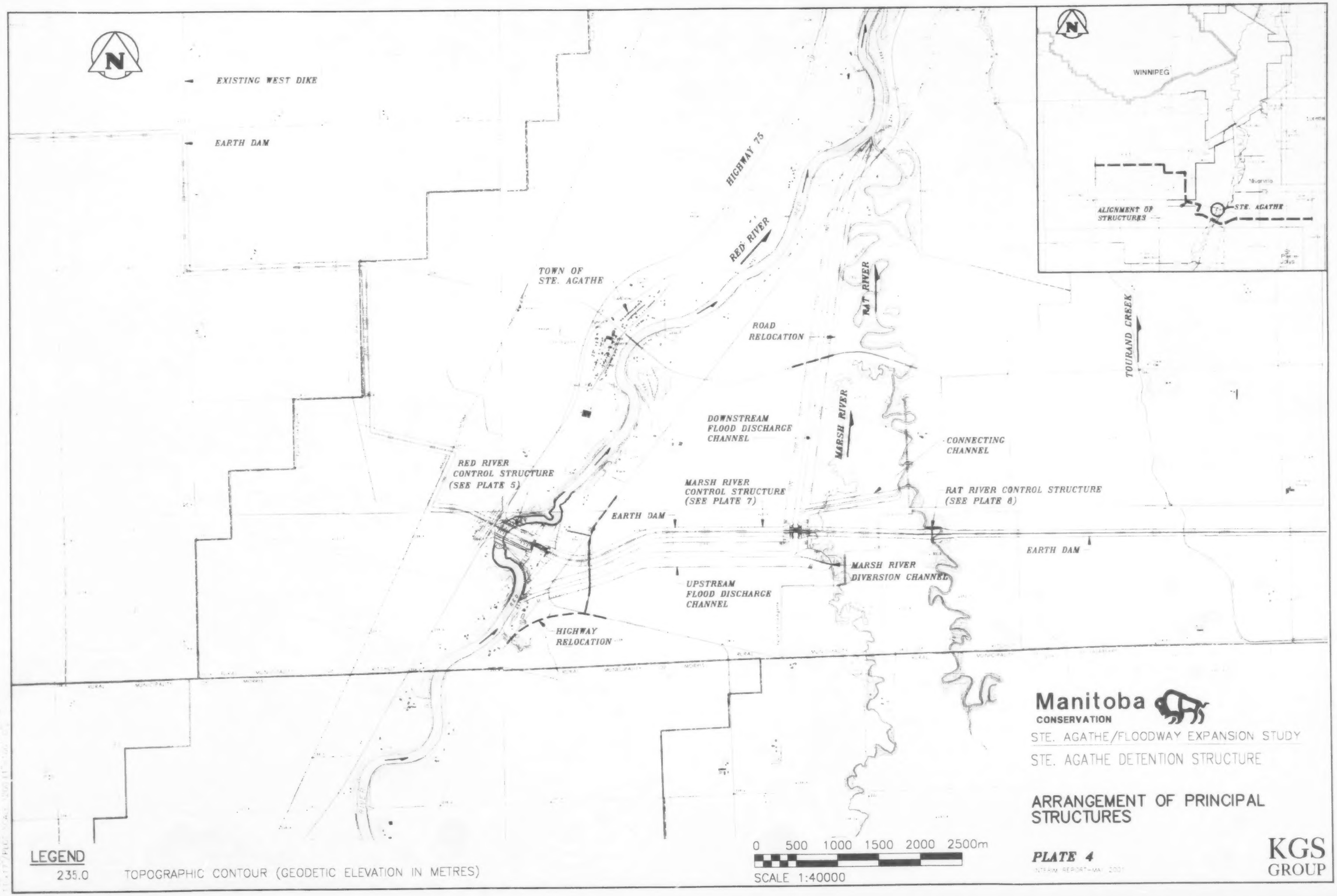
STE. AGATHE/FLOODWAY EXPANSION STUDY

STRATIGRAPHIC PROFILE ALONG CENTER OF FLOODWAY CHANNEL

PLATE 3

INTERM REPORT–MAY 2001

KGS GROUP



LEGEND

235.0 TOPOGRAPHIC CONTOUR (GEODETIC ELEVATION IN METRES)

0 500 1000 1500 2000 2500m

SCALE 1:40000

Manitoba
CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

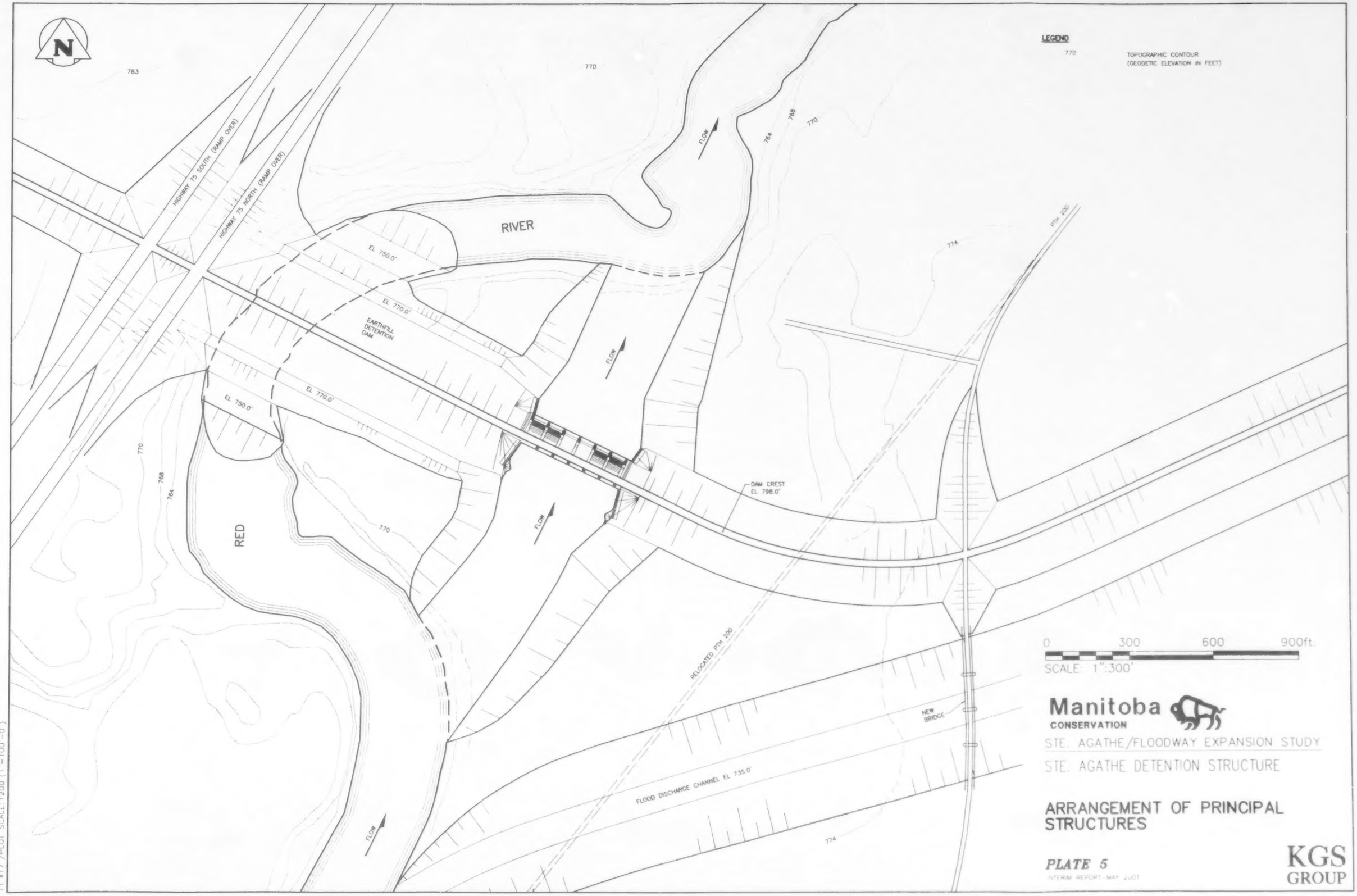
STE. AGATHE DETENTION STRUCTURE

ARRANGEMENT OF PRINCIPAL STRUCTURES

PLATE 4

INTERIM REPORT - MAY 2001

KGS GROUP



Manitoba CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

STE. AGATHE DETENTION STRUCTURE

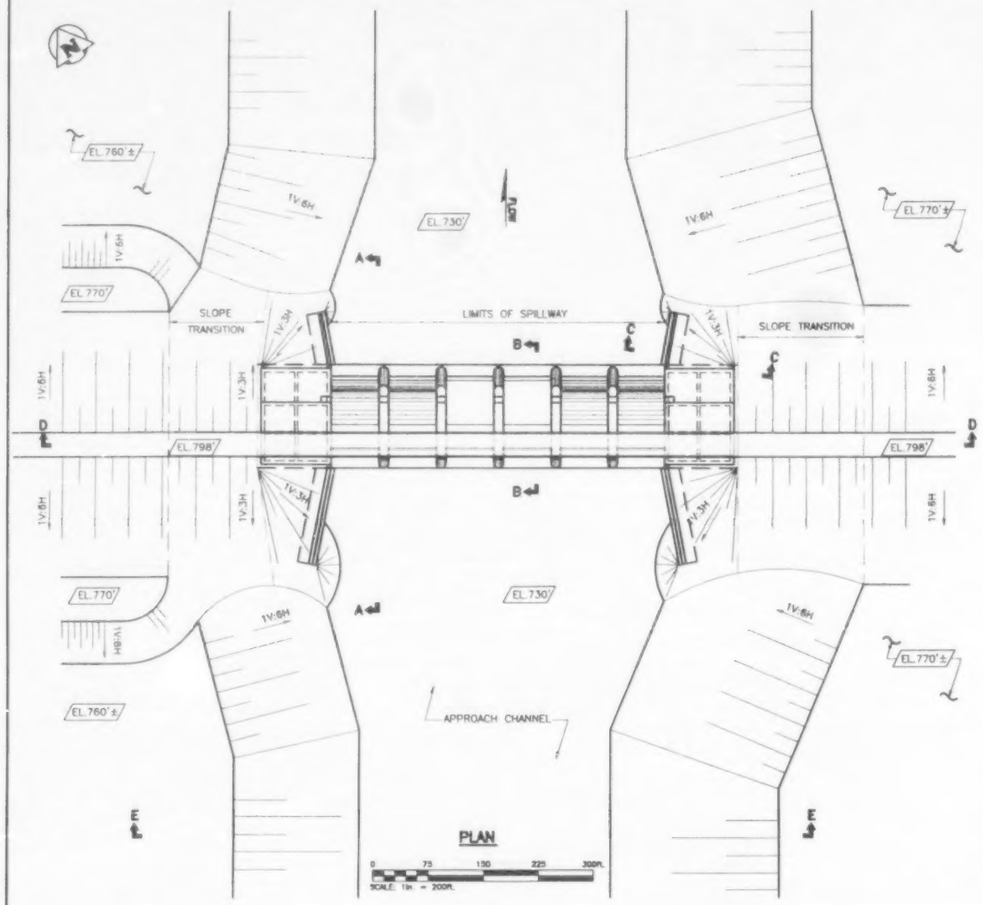
ARRANGEMENT OF PRINCIPAL STRUCTURES

PLATE 5

INTERIM REPORT - MAY 2001

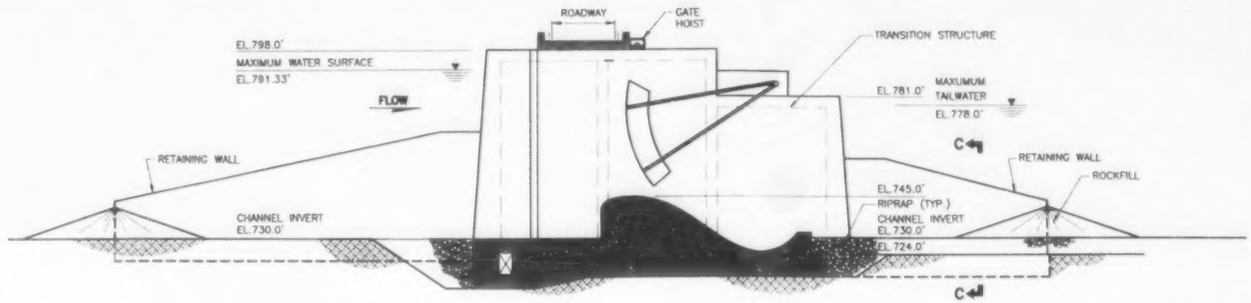
KGS GROUP

KGS FILE NO.: 00-311-07.35-PL05rev0.dwg
11"x17"/PLOT SCALE: 1200 (1"=100'-0")

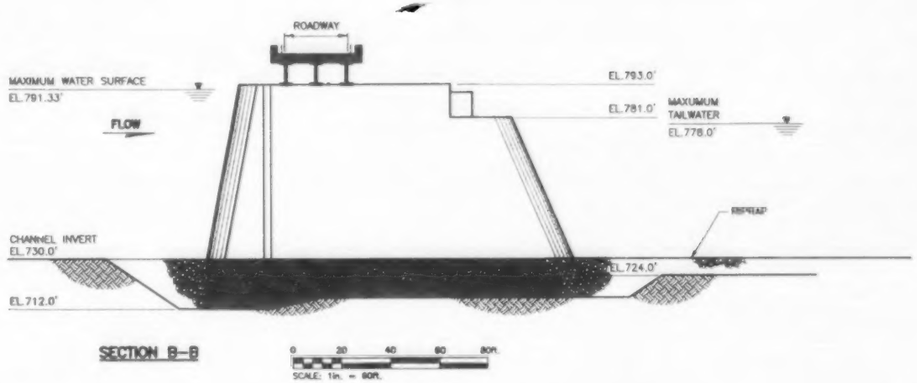


PLAN

SCALE: 1in. = 200ft.

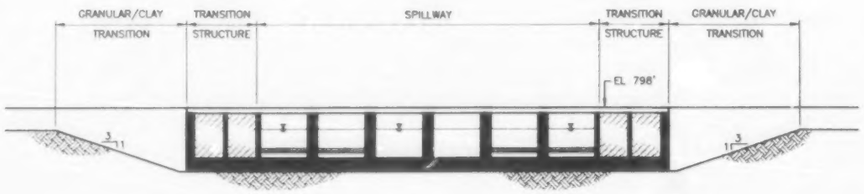


SECTION A–A

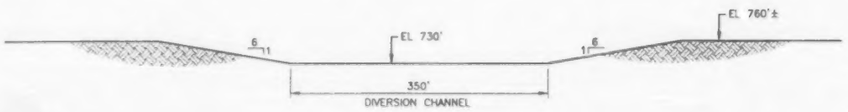


SECTION B–B

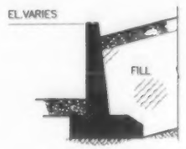
SCALE: 1in. = 80ft.



SECTION D–D



SECTION E–E



SECTION C–C
(RETAINING WALL)

Manitoba
CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

STE. AGATHE DETENTION STRUCTURE

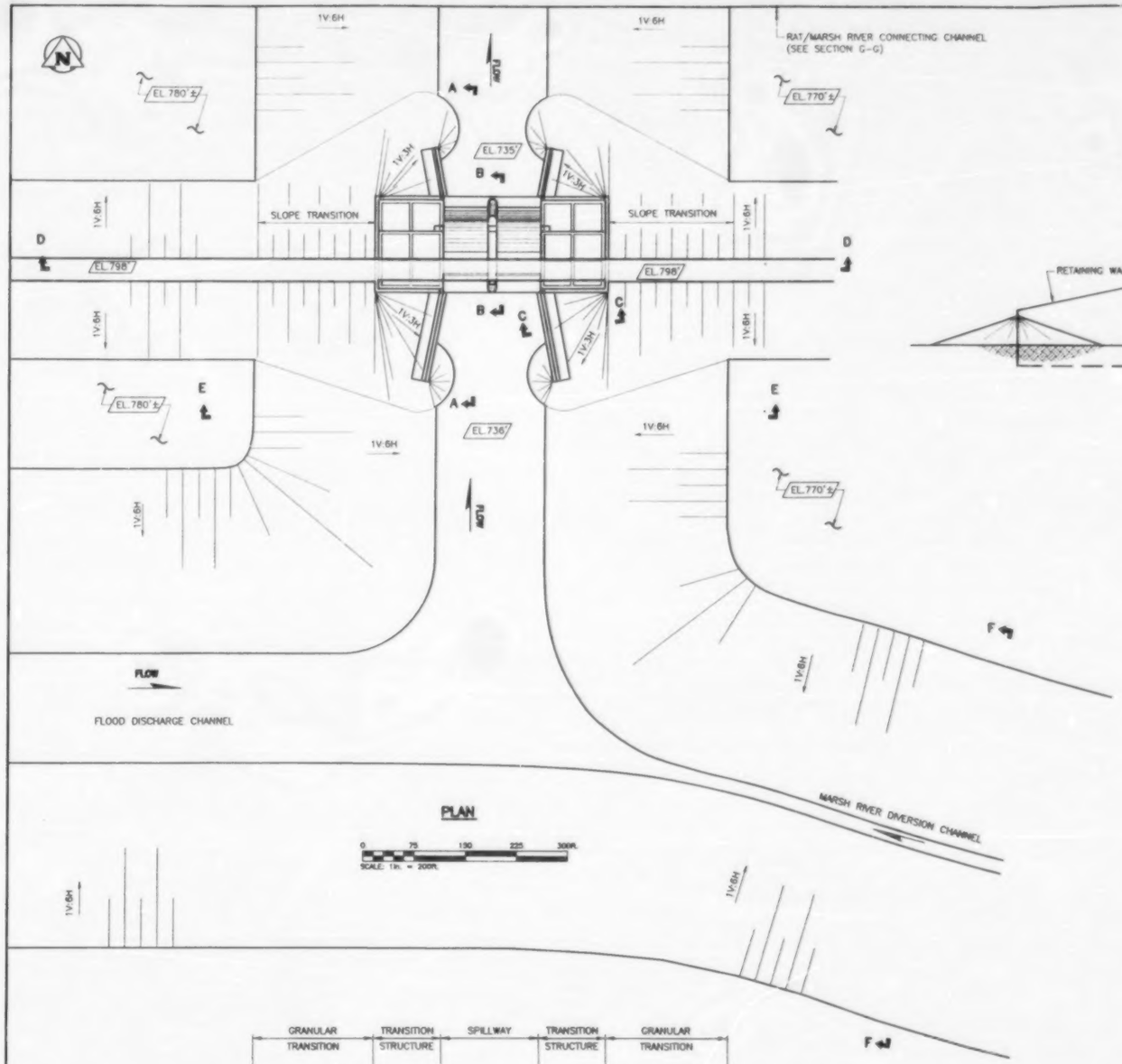
RED RIVER CONTROL STRUCTURE

PLATE 6

INTERIM REPORT–MAY 2001

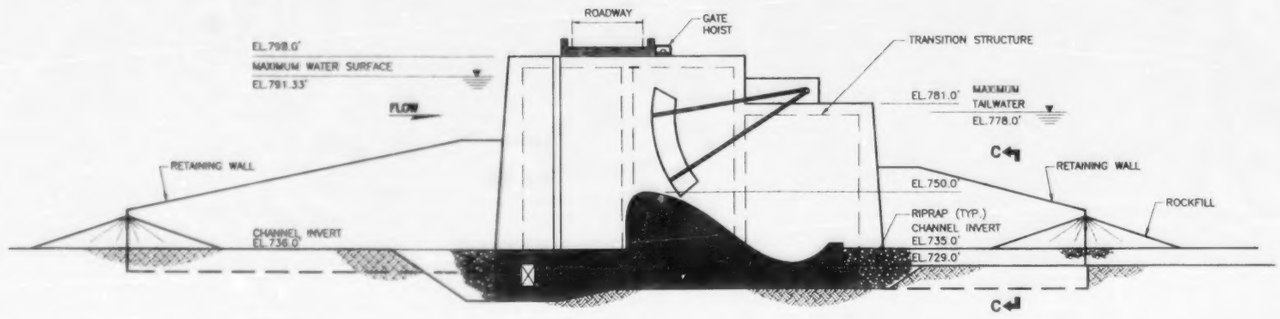
KGS GROUP

KGS FILE NO.: 00-311-07 35-PL06rev0.dwg
11"x17"/PLOT SCALE: 1200 (1"=100'-0")

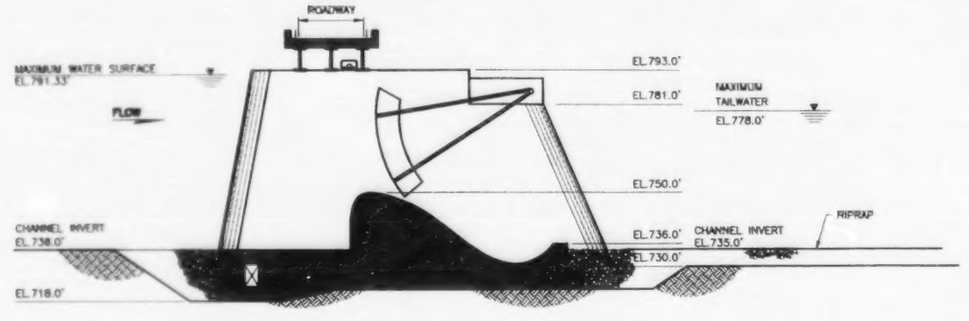


PLAN

0 75 150 225 300ft.
SCALE: 1in. = 200ft.

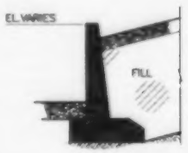


SECTION A–A

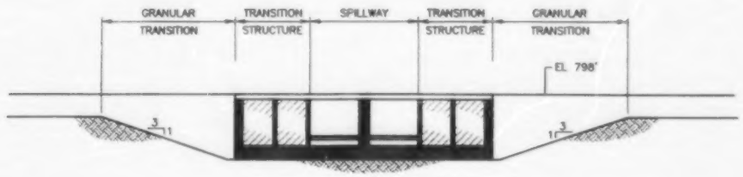


SECTION B–B

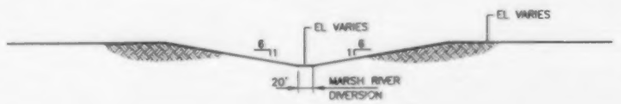
0 20 40 60 80ft.
SCALE: 1in. = 60ft.



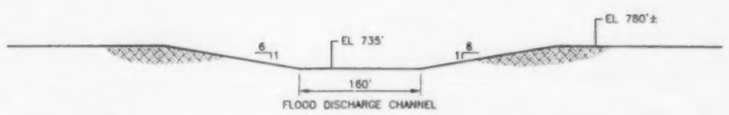
SECTION C–C
(RETAINING WALL)



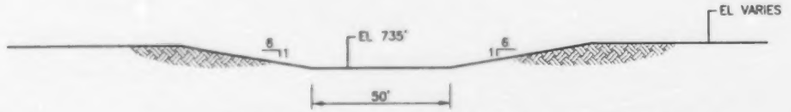
SECTION D–D



SECTION F–F



SECTION E–E



SECTION G–G (RAT/MARSH RIVER CONNECTING CHANNEL)

Manitoba
CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

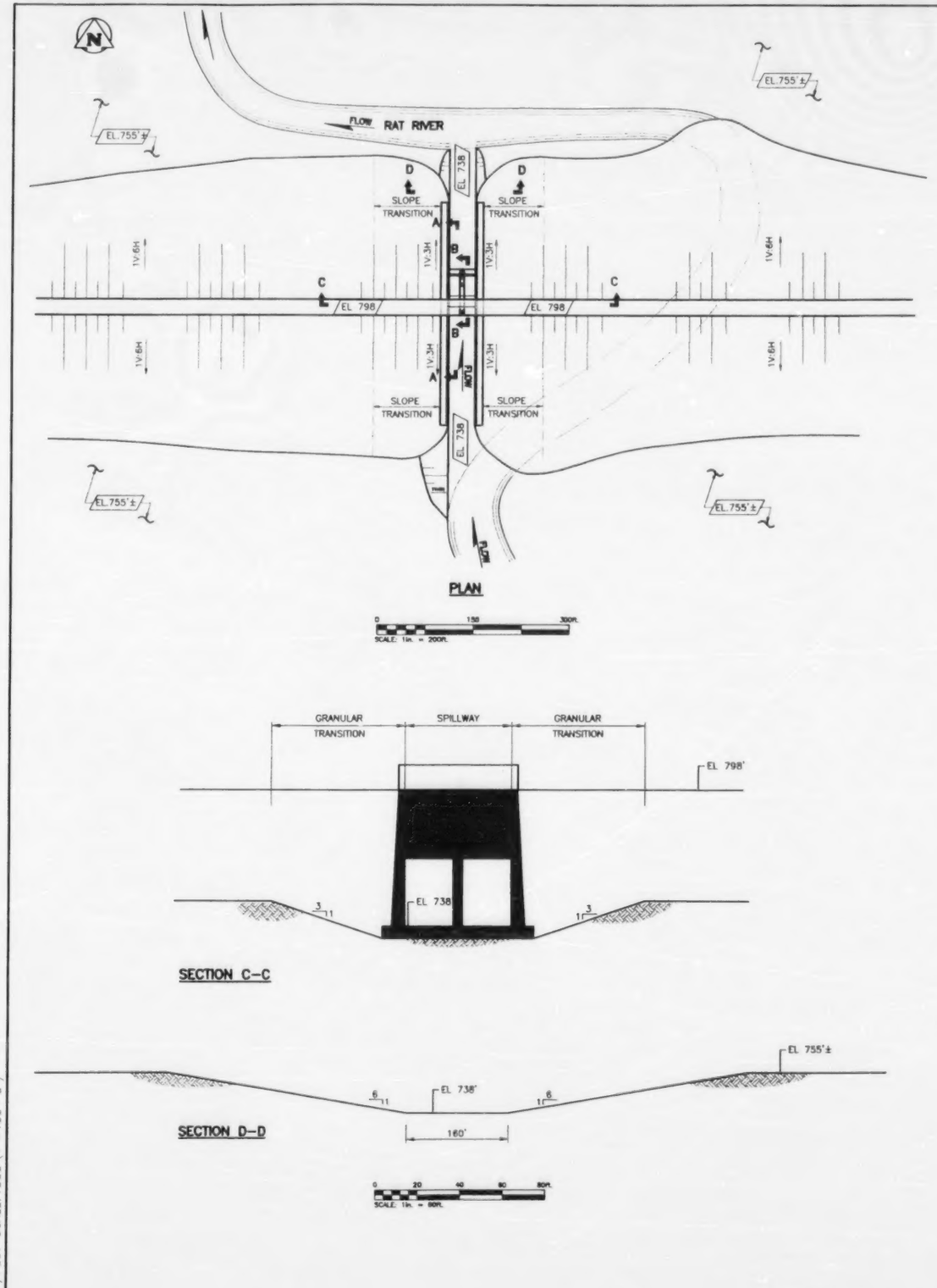
STE. AGATHE DETENTION STRUCTURE

MARSH RIVER CONTROL STRUCTURE

PLATE 7
INTERIM REPORT–MAY 2001

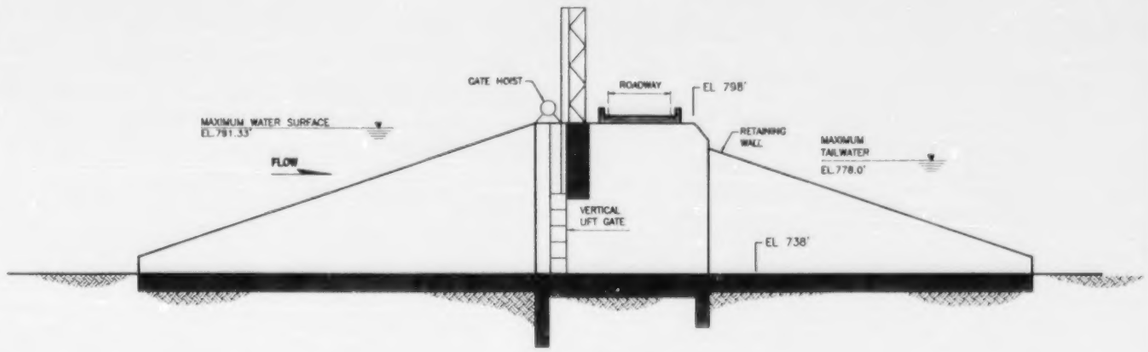
KGS GROUP

KGS FILE NO.: 00-311-07.35-PL07revD.dwg
11"x17"/PLOT SCALE: 1200 (1"=100'-0")

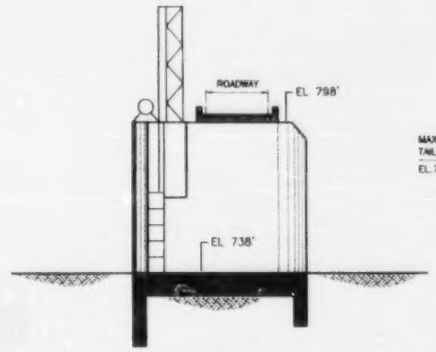


PLAN

SCALE: 1in. = 200ft.



SECTION A–A



SECTION B–B

SCALE: 1in. = 80ft.

SECTION C–C

SECTION D–D

SCALE: 1in. = 80ft.

Manitoba
CONSERVATION

STE. AGATHE/FLOODWAY EXPANSION STUDY

STE. AGATHE DETENTION STRUCTURE

RAT RIVER CONTROL STRUCTURE

PLATE 8

INTERIM REPORT–MAY 2001

KGS GROUP

KGS FILE NO.: 00-311-07.35-PL08rev0.dwg
11"x17"/PLOT SCALE: 1200 (1"=100'-0")